THE JOURNAL

OF THE

Quekett

MICROSCOPICAL CLUB

EDITED BY

FRANK P. SMITH.

SECOND SERIES.

VOLUME X.

1907-1909.

London:

[PUBLISHED FOR THE CLUB]

WILLIAMS AND NORGATE,

14, HENRIETTA STREET, COVENT GARDEN, LONDON,

AND 7, BROAD STREET, OXFORD.

PRINTED BY
HAZELL, WATSON AND VINEY, LD.,
LONDON AND AYLESBURY.

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THE JOURNAL

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ON THE REPRODUCTION OF MOSSES AND FERNS.

By J. Burton.

(*Read October 19th,* 1906.)

It is to my mind always desirable as far as possible to avoid technical terms, especially in botany, which, probably with good reason, appears to have a bad reputation for uncouth terminology. I have, therefore, endeavoured in the present paper to adopt the simplest language consistent with accuracy, and by "mosses and ferns" wish to indicate those plants which would be so named by any unscientific person. It will, however, be as well in the first place to point out the position of these plants in the vegetable kingdom, and to refer briefly to their relationships. Both belong to the great division known as the Cryptogams, the word implying that the sexual aspects of their reproduction are hidden or unknown, and though correct enough at the time when it was bestowed, the term is now no longer appropriate in that sense, at any rate for the greater part of the class. The lower groups consist of the Algae and Fungi, with which we are not dealing; then come the Bryophyta, more or less moss-like plants, many of them well known to microscopists on account of the number of interesting objects which they afford; and finally, the Vascular Cryptogams, one section of which is the ferns, as popularly understood. In point of histological structure these last show a great advance on the others. Of course, there is considerable variation in details, but, large as are the two divisions and numerous as to species, notwithstanding great differences in the plants them selves, the organs of reproduction are very similar throughout*;

* This is especially true of the female organ, known as the "archegonium."

and having once become thoroughly acquainted with the typical structure and methods it is easy to understand the analogies and the processes in the whole of the Bryophyta and Vascular Cryptogams.

Looking at the vegetable kingdom in general we see that plants have an immense variety of methods of propagating themselves. They may do so, for instance, by means of portions broken off, by division of the root stock, by small bulbs produced upon various parts, by runners and offsets, and so on. But these plans, although exceedingly efficient in increasing the number of individual plants, can hardly be looked upon as reproduction except in the widest sense. They provide for the extension of the individual, but as there is usually no return to and development from the simpler form of the single cell, we are justified in regarding such instances as not being reproduction in its true, or, at least, in its narrower sense. Confining ourselves to the more restricted meaning of the word we find two main systems of reproduction,—(1) the sexual, which prevails—to outward appearance, at any rate—almost exclusively in the higher plants, where the life-cycle consists of a mature plant which produces seeds, which in due course ripen, germinate, and give rise to a new individual like the parent; and (2) the non-sexual system by means of spores, which give rise to an organism like that from which they are derived, this form of reproduction being mainly prevalent in the lower orders. In the two groups, the mosses and ferns, now under consideration, the most characteristic feature is that both these methods are developed to their fullest in one life-cycle. This life-cycle as a whole is spoken of as an *alternation of generations.* The term does not well express the truth, but it is in general use and has some conveniences. It implies that, where it exists, a plant does not reproduce its own likeness in its immediate descendants, but another form, which, again, instead of giving rise to progeny like itself, reproduces the form of its own parents. Moreover, one of these two forms is dependent for its origin on sexual reproduction, while the other is produced non-sexually.

Taking the moss first, it will be as well to commence with the part of the cycle which is generally known, and then discuss that which is less evident. The moss plant bears the sexual organs in the alternation of generations, and is known as the "oöphyte"; this is an awkward term, but it will save some trouble further on to become acquainted with it now. It simply

means the "egg-plant," and indicates the sexual character of the organs present. The male and female flowers, as we may almost call them, are usually situated upon different plants. In the male the top of the stem is in most cases considerably broadened out, resembling what is known as a receptacle in an ordinary flower. This is surrounded by a rosette of leaves, and on it are found a number of club-like bodies called "antheridia," attached by short stalks. Amongst them are some peculiar bodies known as "paraphyses," whose use is not quite certain, and also some more or less modified leaves; but the antheridia are the essential parts of the structure. They have a wall one cell thick, and on maturity are entirely filled with cells, called "sperm-cells," each containing a coiled spermatozoid, these being the immediate fertilising agents. When ripe and in the presence of water, the antheridia open at the apex. I think the paraphyses absorb water, and, swelling, cause pressure to assist this operation. The sperm-cells come out, and in a few moments the thin cell-walls are dissolved. The spermatozoids are thus set free, and progress through the water by the help of two long flagella. The male flowers are not at all difficult to find in a tuft of the very common moss *Funaria*, and are especially large and easily seen in *Polytrichum*, the aid of a magnifier being unnecessary. The female plants are not so easily distinguished. The archegonia are found, usually several together, at the top of the stem, which is but slightly broadened, and they are surrounded by leaves forming a kind of bud. They are flask-shaped bodies, with a long tubular neck, and in the lower swollen part is situated the germ-cell or oösphere. Above this, running through the neck, is a line of cells which in the ripe organ become gelatinous in the presence of water, and emerge by forcing open the top of the receptacle. Any spermatozoids that may be near are attracted by this mucilage, it having been proved that the actual attractive substance is cane sugar. The motile spermatozoids swarm down the canal in the neck of the receptacle until one of them arrives at the germ-cell. A union between the male and female element then takes place, this constituting the process of fertilisation. The germ-cell is now practically a seed, and did it belong to an ordinary flowering plant it would mature, ripen, fall off, and germinate in due course. But, in the mosses, germination begins at once, and moreover, it takes place within the archegonium. The embryo plant, for such it really is, elongates and becomes spindle-shaped. The lower part penetrates the tissue of the stem of the parent

moss, whilst the upper finally develops into what is known as the capsule. In the capsule a ring of tissue is differentiated, which gives rise to the mother-cells of the spores. The archegonium for some time grows with the capsule, but at last the lengthening stalk tears it at the base, when it is carried up and forms the "calyptra," the outermost covering of the capsule. Under the calyptra there is a kind of lid—the "operculum"—and below that, surrounding the mouth of the capsule, there is, in many species, a peristome composed of variously arranged teeth, whose purpose is subservient to the dissemination of the spores. The base of the embryo penetrates the tissue of the upper part of the stem of the parent, but probably the stem grows up round it also. It is from this source that the moss capsule derives part of its nourishment; it has no root of its own, and no separate existence apart from its parent. Although generally regarded as being merely the fruit, it is in reality, as I have endeavoured to show, a second generation, derived from the fertilised germ-cell borne by the original moss plant. At the same time, although it is usually described as parasitic upon its parent, it is only very partially so, and from its structure (to be again referred to) is obviously able to obtain its carbon directly from the air, as well as any other plant. The capsule is called a "sporophyte," because, regarded as a separate individual, it produces spores, these being non-sexual reproductive bodies, containing no embryo, but having an outer somewhat tough coat and an inner thin one, and filled with protoplasm, some oil and chlorophyll. On the commencement of growth the outer skin is burst, and the inner, protruding, at one part forms a rudimentary root, and opposite to that a much-branched structure, in most species resembling some of the common filamentous algae. It is composed of numerous cells, contains abundant chlorophyll, and is called a "protonema." After a time some of the branches of the protonema produce buds, from which roots spring and take a downward direction, while a stem grows upwards and forms leaves, becoming a moss plant identical with that from which we started. Thus, to complete the life-cycle, the so-called alternation of generations, three stages are necessary,—(1) the moss plant which bears the sexual reproductive organs; (2) the capsule produced by these, which, though living on the parent, is really the next generation: this forms non-sexual spores, which give rise to (3) the protonema, on which arise as branches (not as a separate organism) the leafy stems with which we started.

Taking now a fern as popularly understood, it is unnecessary to attempt any description of the plant, it being so well known. Almost any common species will answer our purpose—for example, the male fern or the common bracken. On some part of the leaf, normal or modified, are found the well-known sporangia or spore cases. They are disposed in a great variety of ways, according to the species,—sometimes collected in groups, either covered by a membrane called the "indusium," or without it; or arranged along the edge of the leaf, or along the sides of the veins. The form of the sporangium is very similar in all the species. It consists of a membranous pouch or bag, somewhat pear-shaped and flattened, and round the edge or in a circle at the top is a ring of cells, the annulus, which, when the structure is ripe, and on suitable conditions supervening, breaks, and tears the bag, releasing and scattering the spores. The shape of the spores which are formed from the mother-cells is well known, they being amongst the commonest of microscopic objects. In most species they are brown, but some are green owing to the presence of chlorophyll. The vitality of the former endures for a long period, but the latter will not germinate unless sown when fresh. *Osmunda*, the so-called flowering fern, has spores of this latter type. For experimental purposes the spores may be thinly sown on small pieces of flower-pot, which should be placed in a saucer with a little water in it, and covered with a glass; but in this way it is scarcely possible to obtain the full development, as would be the case if the sowing were made on damp earth or sand. In a few days the outer tough coat bursts, and growth commences, much as in the case of the moss spores already described. In some species of ferns for a considerable time only a filament of cells is formed, which at last, however, broadens out into a leaf-like structure. In *Osmunda* the expansion is formed at once without any preliminary filament. This structure is the prothallus, and on it are formed the sexual reproductive organs of the fern. A portion in the centre becomes thicker than the rest, which consists of one layer of cells only. The rhizoids or root-hairs usually spring from this part, which is known as the "cushion." The antheridia may arise on almost any part of the prothallus; they consist of a ring of cells and one forming a lid, and contain the spermatozoids. In the ferns the spermatozoon is a coiled filament something like a corkscrew, with several cilia at one end, by the aid of which it moves through water. The archegonia, the female organs, are formed

on the thick cushion of the prothallus, among the rhizoids. They have a neck projecting beyond the surface, reminding us of the similar organs among the mosses: but there is no swollen lower part, as in the former case; the body or "venter," as it is called, is formed of the neighbouring cells of the prothallus itself. The oösphere or germ-cell lies in the venter, and a line of cells in the neck, on the maturity of the organ, becomes gelatinous, and forces open the neck, some of it emerging. Into this the spermatozoids swarm, and, attracted by the presence of malic acid, proceed down the canal. Finally one reaches and combines with the germ-cell, and thus fertilisation is brought about. The germ-cell, now the embryo, undergoes cell-division and develops into a young fern, it being nourished by the prothallus until leaves are formed. Thus we return to the fern plant bearing non-sexual spores, from which we started.

From this description it is at once obvious that the fern plant itself does not correspond in the life-cycle with the moss plant, but with the capsule of the moss, as they alike produce non-sexual spores, and each of them is the sporophyte portion of the cycle. It follows that the inconspicuous prothallus of the fern is represented by the leafy stem of the moss, as they alike bear the antheridia and archegonia, and are the oöphytes in the cycle. This is a most important distinction, for although the Bryophyta and Vascular Cryptogams are by some united as the Archegoniateae, because of the similarity of the female organs in the two groups, yet it is between them that the parting of the ways occurs. In the ferns and all above them the sporophyte is the manifest plant; while below the ferns, beginning with the mosses, it is the member of the life-cycle which bears the sexual organs—in short, the oöphyte—which is the more conspicuous, and the spore-bearing portion is usually looked upon merely as the fruit, though really another generation.

It will, perhaps, be a surprise to some to learn that in ordinary flowering plants—technically the Angiosperms—it is the sporophyte which is the visible and commonly known portion of the life-cycle; or, indeed, that any alternation of generations can be recognised in the sense in which I have used the expression. Yet such is the fact. The matter is much too lengthy and intricate to be effectually treated here; but although we can all see and are acquainted with the sexual reproduction in these higher forms, it must be remembered that underlying it, although much modified, and unintelligible except when compared step by step with

the ferns, there is the equivalent of the spores and prothallus of the Vascular Crytogams.

Before concluding, I should like to say a few words on a general principle suggested by my subject. It is a well-known fact that, to ensure vigorous and healthy plants, an occasional return to propagation by seeds is necessary. A constant recourse to vegetative reproduction by means of cuttings and similar methods invariably results in degeneration and a liability to disease. Sexual reproduction, therefore, evidently leads to a greater development of vitality or strength of constitution than mere vegetative reproduction. The principle I wish to bring to your notice is another phase of this law. It is that the highest structural development also is only attained by sexual reproduction as contrasted with that which occurs owing to the non-sexual, even though both are included in one life-cycle. This is very beautifully illustrated by the alternation of generations in the two groups under consideration. In the ferns, for example, the spores which are non-sexual produce a prothallus, a simple cellular structure consisting mainly of a single layer of cells, without vascular bundles, epidermis or true roots, showing altogether but little differentiation of tissues. Upon it arise the antheridia and archegonia, and on the union of their essential parts—that is, on sexual reproduction taking place—a fern plant results. It is very obvious that the structure of this is of a far higher order than that of the prothallus. The fern has exceedingly well-developed vascular bundles, epidermis and stomata—in fact, all the structure of the highest plants; but from its non-sexual spores, again, only the prothallus results. In the mosses the case is not quite so evident, but a glance beneath the surface shows that not less there also, a union of the sexes produces a far higher development than the more simple process. The occurrence of the protonema tends to confuse comparison somewhat, but it may be looked upon as only an early condition of the leafy stem, and is not, in fact, a distinct organism. On examining, then, the leafy stem arising from the non-sexual spore, it is found to be of the simplest construction, notwithstanding its appearance to the contrary. It is but a kind of parody of the outward form merely of the vascular plants. It is all cellular tissue; there are no true vascular bundles, no epidermis, and, of course, stomata are absent. The organs which I have called "roots" are not roots morphologically, although acting as such. We have seen here that the fertilised germ-cell gave rise to the

capsule as the next generation, and singular as it appears, the moss capsule attached to the parent, and seeming only like its fruit, is of a far higher organisation, and exhibits many of the characteristics of the very highest plants. At a mere glance we see a much more considerable differentiation of tissues than the moss can boast of. In the centre there is a white large-celled mass, the columella, corresponding to the colourless inner tissue of the flowering plants; then there is the ring of spore-producing tissue. Outside this is an air space, crossed by alga-like threads containing chlorophyll, joining on the outside the sub-epidermal tissue, and finally a strongly developed epidermis, in many mosses containing stomata not differing from those of the Phanerogams. These are most remarkable, considering the position the mosses occupy. But again, the non-sexual spores from this complicated organism give rise only to the simple protonema and the almost entirely cellular leafy stem with which we started. But if it is true that the highest development only results from sexual reproduction, the converse is equally true; and hence in the most highly developed plants we find sexual reproduction has become emphasised, as it were, whilst reproduction by means of spores is so obscured that on a superficial view it appears to be absent. Again, in the plants less highly developed than the Bryophyta—namely, the Algae and Fungi—the non-sexual reproduction is paramount, while the sexual is pushed aside till it is often most difficult to detect. Thus the mosses and the ferns display in their alternation of generations a typical representation of the methods of reproduction in the whole vegetable kingdom. In them the two phases, the sexual and the non-sexual, are balanced; neither is developed at the expense of the other, and the importance which belongs to them in this respect as an indication of the processes which occur in the other divisions can hardly be overrated.

THE BRITISH SPIDERS OF THE GENUS *LYCOSA.*

By Frank P. Smith.

(*Read November 16th*, 1906.)

Plates 1—4.

In publishing this short paper on the genus *Lycosa*, I am doing so in the hope that it will prove of service not only to the advanced araneologist for purposes of reference, but to the beginner who must, at some time or other, have felt the want of a list of spiders giving the more important synonyms and specific characters in a concise form, and also figures of the most striking structural peculiarities. Many years of work with the Araneae has convinced me that a great deal of the neglect which this group has suffered at the hands of students of natural science is attributable to the fact that the available literature is far from being either sufficient or convenient. Obviously, a beginner cannot work from a list pure and simple, and beyond such there is little araneological literature in the English language, except two important works dating back to 1864 and 1879 respectively, and a few scattered papers dealing chiefly with rare and little-known species.

Personally, I consider it altogether a mistake to suppose that, for practical purposes, an elaborate monograph is a necessity, or even, by itself, a convenience, at any rate to the beginner. I do not refer so much to the awkwardness attendant upon the handling of large and ponderous volumes when one is working amongst a congested array of specimen jars, optical appliances, and, worst of all, saucers of spirit, although this is a matter well worthy of consideration. I refer more particularly, however, to an aspect of the matter which often escapes attention. A monograph contains—or, at any rate, should contain—full and complete descriptions of all those species with which it professes to deal; and it should be the aim of the author, although obviously a line must be drawn somewhere, to make the descriptive matter as detailed as is consistent with practicability. Similarly, in the case of species described as

new, the author, unless he wishes to bequeath to future workers a source of endless annoyance and dissention, should endeavour to omit nothing from his description which could possibly be of importance in the identification of the species in question.

But let us now take, for example, the case of the genus *Lycosa*. We have in this country eighteen species, and a full and detailed description of any one of them might well occupy half the space allotted to this entire introduction. Supposing, now, that a beginner attempted to identify a specimen by the aid of a monograph of the genus *Lycosa* written on these lines. It is clear that all the family and generic characters would be repeated in the description of each species, and although the specific characters would, truly enough, be faithfully included, they would constitute so small a percentage of the whole that the inexperienced worker would, in all likelihood, be utterly incapable of satisfactorily disentangling them from the preponderating verbose mass. Clearly, what is needed is a concise comparison of the various species with the descriptions limited to characters which are not common to the whole genus, and which are thus likely to be of assistance, even if not of primary systematic importance, in deciding upon the identity of a specimen under consideration. I do not mean to suggest for a moment that the student should be contented with any conclusions which may be drawn from tables of differences or abbreviated descriptions. To adopt such a course would be to court disaster, and one must never lose sight of the real nature of tables, etc., designed merely to facilitate the separation of genera or the determination of species. They are, to use a figure of speech, the "finders" on the main telescopes; we cannot, by their aid alone, learn everything which is to be learnt, but yet without them we feel, at any rate in our early studies, supremely helpless. Analytical tables are now much in vogue, but, whilst admitting their undoubted value, I personally prefer the use of abbreviated descriptions as being far less mechanical and far more likely to impress on one's memory the salient features of the various species.

I would strongly advise the beginner, whether he be working from abbreviated or from full descriptions, to adopt a process of elimination. Supposing we wish to determine the family to which a spider belongs. The first step is to make a rough list of

the British families, omitting, where our knowledge enables us to do so, any to which it is obvious that the specimen cannot belong. Then, taking the more important characters, one by one, we proceed to eliminate the families. Perhaps we notice that the spider under examination has eight eyes. Immediately we can draw a pencil through those families in which the eyes number six. If its tarsal claws are three in number, the families possessing but two claws are eliminated. In this way we soon arrive at the end of our task, having, in the process, acquired a good deal of useful knowledge. The family found, we can, by a similar method, determine the genus and species.

I also advocate the omission from all papers, other than original descriptions or monographic publications, of detailed descriptions of specific characters furnished by organs of great complexity. The structure of the palpus of the average male spider, for example, is for practical purposes indescribable. At any rate, a description, however minute its details, cannot reasonably be expected to replace a carefully drawn figure of the organ in question; and if the latter exists, whence comes the necessity for the former? As a practical proof of the truthfulness of these remarks, read carefully the detailed description of the palpus of some species of spider in any first-class monograph, and then attempt to sketch the object described. A subsequent comparison of the result with the author's own figure will be sufficient proof of the inadequacy of language to convey to one's mind the form of a complex object with which one is not well acquainted. The expert may be able to form a fairly accurate mental picture from a good description, especially if this be written by an author with whose style he is acquainted; but with all due deference to the expert, the needs of the beginner ought, perhaps, to have first claim on our attention, for, unlike the advanced student, he is not in a position to compile analytical tables or reference lists for his own use, but is dependent for his information upon those whose experience has enabled them to do so.

The question of synonyms next claims our attention. In the case of common species it is altogether impracticable to give anything like a complete list of references, and, in fact, no useful purpose could be served by so doing. A very long list often becomes an encumbrance, and seldom really justifies its existence.

The almost entire omission of synonyms, as practised by some authors, cannot, of course, be supported, and the elimination of references to works of early date is objectionable, as there is, undoubtedly, a great deal of revision yet necessary in the matter of nomenclature, and in this connection the early authors will have to be most carefully studied. It is, however, often a matter of the greatest difficulty to satisfactorily decide, from the altogether insufficient descriptions and purely superficial figures of the early writers, the identity of the species to which their names were applied, and there is, in many cases, ample evidence that, owing partly to the imperfection of the available optical appliances and partly to the small amount of attention paid to obscure structural details, two or more species were often included under one name. Of course, for the purposes of the practical student, the more modern writings of Continental authors are invaluable; but references to several of the most important of such works will generally suffice, without the necessity for burdening our synonyms with details culled from faunistic publications. In the following list I have selected the synonyms after careful consideration of these various points, and I have included, wherever they exist, references to the following works :—

1757. Clerck, *Svenska Spindlar*.
1758. Linnaeus, *Systema Naturae*, Ed. X.
1831—1848. Hahn, C. W., & Koch, C. L., *Die Arachniden*.
1861. Westring, N., *Araneae Suecicae*.
1861—1864. Blackwall, J., *A History of the Spiders of Great Britain and Ireland*.
1866—1879. Menge, A., "Preussische Spinnen," in *Schriften der Naturforschende Gesellschaft zu Dantzig*.
1870—1873. Thorell, T., *Remarks on Synonyms of European Spiders*.
1874—1884. Simon, E., *Les Arachnides de France*.
1879—1881. Cambridge, O. P. *The Spiders of Dorset*.
1892—1897. Chyzer, C., & Kulczynski, L., *Araneae Hungariae*.

I have made no attempt to give definite details of distribution. So few British areas have been at all systematically worked that anything more than general remarks would be useless and probably misleading. For details as to collecting and preparing

specimens, see *Journ. Q. M. C.*, ser. 2, vol. 9, No. 54, April, 1904, and the references there given. The drawings, except where otherwise stated, are from spiders in my own collection, and have been made, in every case, whilst the specimen was immersed in spirit.

Family LYCOSIDAE.

Eyes, eight in number, of a well-developed type. Four small eyes form a transverse row upon the front part of the head, the remaining eyes, much larger in size, forming a quadrilateral figure upon its upper surface.* Male palpus devoid of the processes known as "apophyses" found in the majority of spiders. Spinners normal. Tarsal claws, three.

The Lycosidae, popularly termed Wolf-spiders, are amongst the best known of our indigenous species, many of them being abundant in almost every part of the British Isles. They may be recognised with very little difficulty by the arrangement of the eyes. *Lycodia* (*Zora*) of the family Clubionidae and *Textrix* of the Agelenidae have their eyes arranged on a somewhat similar formula; the former, however, has but two tarsal claws, and the latter has abnormally long spinners. *Pisaura* and *Dolomedes*, of the family Pisauridae, closely approximate the Lycosidae; but the quadrilateral figure formed by the four posterior eyes is so wide behind that the eyes might reasonably be said to form a strongly curved row. In addition to this, they are not so sharply divided into large and small, and, what is far more important, the male palpus is provided with an apophysis.

Genus **Lycosa**, Latr., 1804.

Type: *L. lugubris*, (Walck.).

1757. *Araneus*, Clk., *Sv. Spindl.*, p. 22 (*ad partem*).
1758. *Aranea*, Linn., *Syst. Nat.*, Ed. X., vol. i., p. 619 (*ad partem*).
1804. *Lycosa*, Latr., *Nouv. Dict.*, vol. xxiv., p. 135 (*ad partem*).
1848. *Leimonia*, C. L. Koch, *Die Arach.*, vol. xiv., p. 99.
1848. *Pardosa*, C. L. Koch, *Die Arach.*, vol. xiv., p. 100.
1861. *Lycosa*, Westr., *Ar. Suec.*, p. 467 (*ad partem*).
1861. ,, Bl., *Spid. G. B. I.*, p. 16 (*ad partem*).
1876. *Pardosa*, Sim., *Ar. de France*, vol. iii., p. 304.

* For purposes of description, etc., the eyes of the Lycosidae are usually spoken of as "arranged in three rows of 4, 2, 2."

1881. *Lycosa*, Camb., *Spid. Dorset*, p. 369.
1892. „ Kulcz., *Ar. Hung.*, vol. i., p. 50.

This genus is the largest and best known of the family Lycosidae, and, generally speaking, is easily recognised. The eyes are arranged strictly upon the typical Lycosid formula, and the difference in size between the large and small ones is very great. The first row is shorter than the second, and is well separated from the fore-edge of the caput, usually by more than twice the diameter of one of its central eyes. The caput is narrow in front, very high and almost parallel-sided, and the ocular group occupies nearly its entire width. These characters will at once separate the present genus from *Pirata* and *Trochosa*, and to some extent from *Tarentula*; but this latter genus very closely approximates *Lycosa* in some of its species. In *Tarentula*, however, the first row of eyes is usually only a trifle, if at all, shorter than the second, and is seldom separated from the front edge of the caput by more than twice the diameter of one of its central eyes. The sides of the caput are not so nearly vertical as in *Lycosa*, and the ocular group occupies, proportionately, a much smaller area. The species of *Tarentula* are usually larger than *Lycosa*, and the legs are not nearly so strongly attenuated towards their extremities as in that genus. The cephalo-thorax in *Lycosa* is usually marked with a distinct pattern, and this, although based upon a similar formula throughout the genus, varies sufficiently in the different species to be of great value as a specific character. If we consider the darker portions to constitute the groundwork, there are normally three longitudinal, more or less pale bands, one being central and one near to each lateral margin.

All the species of *Lycosa* run freely in the sunshine during the spring and summer months. The females carry their egg-sacs, which are lenticular in shape and of a grey or olive-grey tint, attached to their spinners; and the young, when hatched, are carried for some time upon the back of the mother spider.

Lycosa arenicola, Camb., 1875.

(Pl. 1, Figs. 1, *a*, *b*.)

1875. *Lycosa arenicola*, Camb., *Ann. Mag. N. H.*, ser. 4, vol. xvi., p. 253, pl. viii., fig. 9.

1876. *Pardosa arenicola* Sim., *Ar. de France*, vol. iii., p. 314.
1881. *Lycosa* ,, Camb., *Spid. Dorset*, p. 373.

Length : male, 6 mm. ; female, 7 mm.

Thoracic bands yellowish : central band commencing as a fine line at the ocular area, gradually enlarging towards the centre of the thorax, and then tapering off to its extremity; lateral bands well removed from the margins, and usually each broken into three portions by dark bars. Sternum black. Legs not annulated. Tarsi of the first pair of legs dark, especially towards the extremity, and those of the remaining legs usually tipped with black. Femorae strongly suffused with black, and marked above with distinct pale longitudinal stripes. In the specimens from which my figures were taken, received some years ago from the late F. O. Pickard-Cambridge, the female differs slightly from the type, the central band being somewhat dilated behind the eyes, thus approaching *L. agricola*, Thor.

A rare and local species, which has occurred on several parts of the south coast. It has also been found in France. Adult in June.

Lycosa agricola, Thor., 1856.

(Pl. 1, Figs. 2, *a*, *b*.)

1834. *Lycosa arenaria*, C. L. Koch, *Deuts. Ins.*, 123 ; 15, 16 (*nom. praeoc.*).
1843. ,, *pallida*, Bl., *Trans. Linn. Soc.*, xix., p. 119 (*nom. praeoc.*).
1848. *Pardosa arenaria*, C. L. Koch, *Die Arach.*, vol. xv., p. 36, tab. Dxiv., 1441, 1442.
1851. *Lycosa saccata*, Westr., *Goteb. Handl.*, p. 52 (*nom. praeoc.*).
1856. ,, *agricola*, Thor., *Rec. Crit. Aran.*, p. 61.
1861. ,, *arenaria*, Westr., *Ar. Suec.*, p. 476.
1861. ,, *agrestis*, Westr., *Ar. Suec.*, p. 480 (*ad partem*).
1861. ,, *fluviatilis*, Bl., *Spid. G. B. I.*, p. 31, pl. ii., fig. 13 ; pl. iii., fig. 13.
1867. *Pardosa arenaria*, Ohl., *Ar. Prov. Preuss.*, p. 136 (*ad partem*).
1872. *Lycosa agricola*, Thor., *Rem. on Syn.*, p. 278.
1876. *Pardosa* ,, Sim., *Ar. de France*, vol. iii., p. 311 ; vol. iv., pl. xiii., fig. 27.

1877. *Lycosa agricola*, Menge, *Preuss. Spin.*, p. 541, pl. 88, tab. 307.
1881. „ „ Camb., *Spid. Dorset*, p. 598.
1892. „ „ Kulcz., *Ar. Hung.*, vol. i., p. 55, tab. ii., fig. 11.

Length: male, 5 mm.; female, 5 mm.

Thoracic bands yellowish: central band narrow behind, but somewhat dilated at its fore extremity just behind the ocular area; lateral bands broken up into several portions by broad dark bars. Sternum with a narrow, pale, central, longitudinal band in its anterior half. Legs distinctly annulated, especially in the female. Tarsi of first pair of legs black, except at the base, and those of the remaining legs yellowish or only tipped with black.

This spider, which may be distinguished from *L. arenicola*, Camb., by its smaller size and the strong anterior expansion of the central thoracic band, is by no means rare, but apparently very local. It occurs principally in mountainous districts, and seems to have a predilection for the beds of dried-up streams and the sandy areas exposed by the shrinkage of lakes in the summer season. I have no record of its occurrence in the South of England, but it has a wide geographical range, including Ireland and Scotland, and extending as far as Scandinavia on the north and Turkestan in the east. It is adult from May until July.

Lycosa agrestis, Westr., 1861.
(Pl. 1, Fig. 3.)

1861. *Lycosa agrestis*, Westr., *Ar. Suec.*, p. 480.
1867. *Pardosa arenaria*, Ohl., *Ar. Prov. Preuss.*, p. 136 (*ad partem*).
1870. *Lycosa decipiens*, L. Koch, *Jahrb. der K. K. Gelehr. Gesell. in Krakau*, p. 33.
1872. *Lycosa agrestis*, Thor., *Rem. on Syn.*, p. 282.
1876. *Pardosa* „ Sim., *Ar. de France*, p. 315.
1879. *Lycosa poecila* (?), Herman, *Ungarns Spinnenfauna*.
1892. „ *agrestis*, Kulcz., *Ar. Hung.*, vol. i., p. 56.
1903. „ *decipiens*, Camb., *Proc. Dors. F. Club*, vol. xxiv., p. 161, pl. A, fig. 11.

Length: male, 5 mm.; female, 6 mm.

This species is extremely closely allied to *L. agricola*, Thor. The males usually differ from typical examples of *L. agricola*, Thor., by all the tarsi being black at the extremity only. The females may, in most cases, be distinguished by the black bars breaking the lateral thoracic bands being narrower, and by the bands being much produced anteriorly, often completely encircling the front part of the head. I have never seen a specimen of *L. agricola*, Thor., in which they even approach the face. The sternum in the specimen of *L. agrestis* now before me has broad anterior and lateral bands of a very pale colour, the blackish part being thus reduced to almost a Y-shaped patch.

This spider is supposed to be exceedingly rare in this country, but may easily have been overlooked on account of its resemblance to several other species. I have a female of this species which has lain in a tube for years with some examples of *L. agricola*, Thor. Unfortunately, the exact locality whence it came was not noted, but it is highly probable that it hailed from somewhere in the county of Surrey. It was taken in 1901 or 1902. The only other occurrence of this spider in Britain, as far as I know, is the Rev. Pickard-Cambridge's record from Stratford-on-Avon in 1903 (*Proc. Dors. F. Club*). *L. agrestis*, Westr., seems fairly common on the Continent, and has a wide range—Scandinavia, France, Hungary, etc. Adult in summer.

Lycosa monticola, Sund., 1833.

(Pl. 1, Figs. 4, *a*, *b*. Pl. 4, Fig. A.)

1757. *Araneus monticolus*, Clk., *Sv. Spindl.*, p. 91, pl. 4, tab. 5 (*pre-Linnean*).
1833. *Lycosa monticola*, Sund., *Sv. Ak. Handl.*, f. 1832, p. 175 (*ad partem*).
1836. „ *exigua*, Bl., *Lond. Edin. Phil. Mag.*, ser. 3, vol. viii., p. 490 (*ad partem*).
1837. „ *saccigera*, Walck., *Ins. Apt.*, i., p. 327 (*ad partem*).
1848. *Pardosa monticola*, C. L. Koch, *Die Arach.*, vol. xv., p. 42, tabs. Dxv. and Dxvi. (*ad partem*), 1446, 1448.
1861. *Lycosa* „ Westr., *Ar. Suec.*, p. 487.
1861. „ *exigua*, Bl., *Spid. G. B. I.*, p. 29, pl. ii., fig. 12; pl. iii., fig. 12 (*ad partem*).

1872. *Lycosa monticola*, Thor., *Rem. on Syn.*, p. 285.
1876. *Pardosa* ,, Sim., *Ar. de France*, vol. iii., p. 318.
1879. *Lycosa* ,, Menge, *Preuss. Spin.*, p. 543, pl. 88, tab. 308.
1881. ,, ,, Camb., *Spid. Dorset*, p. 388.
1892. ,, ,, Kulcz., *Ar. Hung.*, vol. i., p. 56.

Length: male, 5 mm.; female, 5 mm.

Thoracic bands yellow: central band very clearly defined, running to a point both anteriorly and posteriorly; lateral bands rather narrow, continued round in front of the head, at least in the female. Often, in the female, there is a second extremely narrow, pale band just above each lateral margin. Sternum of male black; of female, furnished with broad central and lateral pale bands, usually fairly well defined. Legs yellowish, with dark markings on the femora.

This is a fairly common spider in many parts of the country, and seems to have rather a predilection for rich meadows at a fairly high altitude. Adult from May until August. I have records from many parts of England, Scotland, and Ireland. Its Continental range is considerable—Scandinavia, France, Italy, Hungary, etc.

Lycosa purbeckensis, (F. Camb.), 1895.

(Pl. 1, Figs. 5, *a*, *b*. Pl. 4, Fig. B.)

1895. *Pardosa purbeckensis*, F. Camb., *Ann. Mag. N. H.*, ser. 6., vol. xv., p. 32, pl. iv., figs. 1, 4, 7—9.

Length: male, 6 mm.; female, 8·5 mm.

Thoracic bands yellow: central band attenuated both anteriorly and posteriorly; lateral bands narrow, continued round the front of the caput. I have not seen, in the few specimens which I have had an opportunity of examining, any additional lateral bands near the margins, as in *L. monticola*, Sund. Sternum of male with a narrow central, pale band in its forepart; of female, with a central broad band and less distinct lateral bands. Legs very hairy, brown above (in female, yellow beneath), mottled and streaked with black, but not annulated. Metatarsi of first pair in the male furnished with numerous very long bristles. A very rare spider, apparently extremely local—Poole Harbour, etc. Adult in late spring and early summer.

Lycosa purbeckensis, (F. Camb.), var. **minor**, (F. Camb.), 1895.

1895. *Pardosa purbeckensis*, var. *minor*, F. Camb., *Ann. Mag. N. H.*, ser. 6, vol. xv., p. 33.

Length: male, 5 mm.; female, 5·5 mm.

A small form of *L. purbeckensis*, (F. Camb.), taken adult in April on the shores of Solway.

Lycosa promptula, Camb., 1902.

1902. *Lycosa promptula*, Camb., *Proc. Dors. F. Club*, vol. xxiii., p. 37, fig. 11.

Length of female, 3 lines; male unknown.

Thoracic bands yellowish: central band broad behind the eyes, sharply and shortly attenuated; lateral bands moderate. Between the posterior eyes are two yellowish patches. Sternum dark brown. Legs marked with broken annulations upon the femora and tibiae; metatarsi indistinctly annulated. Apparently only found once—near Swanage. I have not seen this spider, but, from the author's careful description, and his figure of the genitalia, I have no doubt that it belongs to the "*monticola*" group, and it would appear to be very closely allied to *L. agrestis*, Westr.

Lycosa herbigrada, Bl., 1857.

(Pl. 2, Fig. 7, *a*, *b*. Pl. 4, Fig. c.)

1857. *Lycosa herbigrada*, Bl., *Ann. Mag. N. H.*, ser. 2, vol. xx., p. 285.
1861. ,, ,, Bl., *Spid. G. B. I.*, p. 22, pl. i., fig. 6.
1861. ,, *albo-limbata*, Westr., *Ar. Suec.*, p. 482.
1872. ,, *herbigrada*, Thor., *Rem. on Syn.*, p. 282.
1876. *Pardosa* ,, Sim., *Ar. de France*, vol. iii., p. 323.
1881. *Lycosa* ,, Camb., *Spid. Dorset*, p. 384.

Length: male, 6 mm.; female, 7 mm.

Thoracic bands yellowish brown, covered with dense greyish white pubescence: central band commencing in front, as a very short, often bifid point, then suddenly becoming extremely wide, then strongly constricted, and finally fairly broad to its posterior termination; lateral bands exceedingly broad, sometimes meeting the central band at some points. Sterum of male with pale

central and lateral bands; in the female these bands have so greatly expanded that the black part is reduced to a few patches, often almost obsolete. Legs yellowish brown, with dark markings and sometimes indistinct annulations. Tarsi and metatarsi of the first pair of legs, in the male, thickened and furnished with numerous erect bristles.

This is perhaps the most striking and beautiful of our indigenous species of *Lycosa*, its pale, hairy clothing rendering it a most conspicuous object. Unfortunately, it is rare and local. It has been taken in England, Scotland, and Ireland, and has a fairly wide range in Europe—Germany, Norway, Russia, etc.; but it appears nowhere to be at all common. Adult in spring and summer.

Lycosa herbigrada, Bl., var. **intermedia,** nov.

(Pl. 4, Fig. D.)

Length: male, 5·5 mm.; female, 6·5 mm.

This variety occupies an intermediate position between *L. herbigrada*, Bl., and *L. palustris*, (Linn.), differing from the former by its somewhat smaller size, by its body being less plentifully supplied with hoary pubescence, and by the central thoracic band being narrower than in that species. This band usually shows some dilation behind the eyes, but it is, as a rule, slight. In some cases, however, it is almost identical with that of the typical *L. palustris*, (Linn.); and the lateral bands are generally intermediate in width between the very broad ones of *L. herbigrada*, Bl., and the narrow ones of *L. palustris*, (Linn.).

This variety appears to be rare, but as it is fairly well known it seems advisable, for the sake of convenience of reference, that it should possess a distinctive title. As I cannot find any note of such a name having been definitely bestowed, I propose the varietal name *intermedia*.

Lycosa palustris, (Linn.), 1758.

(Pl. 2, Figs. 6, *a*, *b*. Pl. 4, Fig. E.)

1758. *Aranea palustris*, Linn., *Syst. Nat.*, Ed. X., i., p. 623 (*ad partem*).
1782. ,, *saccata*, Olafs., *Reise igienn Island*, i., p. 609.
1802. ,, *agilis*, Walck., *Faune Par.*, ii., p. 238 (*ad partem*).
1833. *Lycosa monticola*, Sund., *Sv. Ak. Handl.*, f. 1832, p. 175 (*ad partem*).

1834. *Lycosa paludosa*, Hahn, *Die Arach.*, ii., p. 14.
1836. „ *exigua*, Bl., *Lond. Edin. Phil. Mag.*, ser. 3, vol. viii., p. 490 (*ad partem*).
1837. „ *saccigera*, Walck., *Ins. Apt.*, i., p. 327 (*ad partem*).
1848. *Pardosa monticola*, C. L. Koch, *Die Arach.*, vol. xv., p. 42, tabs. Dxv. and Dxvi. (*ad partem*), figs. 1447, 1449.
1856. *Lycosa tarsalis*, Thor., *Rec. Crit. Aran.*, p. 53.
1856. „ *saccigera*, „ „ „ „ p. 55 (♀ only).
1861. „ *tarsalis*, Westr., *Ar. Suec.*, p. 490.
1861. „ *exigua*, Bl., *Spid. G. B. I.*, p. 29, pl. ii., fig. 12; pl. iii., fig. 12 (*ad partem*).
1867. *Pardosa monticola*, Ohl., *Ar. Prov. Preuss.*
1872. *Lycosa palustris*, Thor., *Rem. on Syn.*
1876. *Pardosa* „ Sim., *Ar. de France*, vol. iii., p. 321.
1881. *Lycosa* „ Camb., *Spid. Dorset*, p. 387.
1892. „ „ Kulcz., *Ar. Hung.*, vol. i., p. 56, tab. ii., fig. 13.

Length: male, 5 mm.; female, 6 mm.

Thoracic bands yellow: central band long and narrow, attenuated anteriorly and posteriorly; lateral bands rather broad, especially in the female, and usually in the latter sex split by a longitudinal dark line or row of minute dark patches. Sternum of male blackish, sometimes with a small, narrow band on its fore-part; of female, with a central band, and more or less distinct lateral ones. Legs dull yellow; femora above with dark patches; tarsi and metatarsi of the first pair of legs in the male, thickened, and furnished with numerous erect bristles.

This species is common in many districts, generally frequenting rich, moist meadows. It has been taken in many parts of England, Scotland, and Ireland, and has a wide Continental range—South France, Norway, Hungary, Turkestan, etc. It is adult from May until September.

Lycosa pullata, (Oliv.), 1789.

(Pl. 2, Figs. 8, *a*, *b*.)

1757. *Araneus pullatus*, Clk., *Sv. Spindl.*, p. 104, pl. 5, tab. 7 (*pre-Linnean*).
1789. *Aranea pullata*, Oliv., *Encycl. Meth.*, iv., p. 218.
1825. *Lycosa paludicola*, Walck., *Faune. Franç.*, p. 26 (*ad partem*).
1833. „ *lignaria*, C. L. Koch, *Deuts. Ins.*, 120; 9, 10.

1841. *Lycosa obscura*, Bl., *Trans. Linn. Soc.*, xviii., p. 611.
1848. *Leimonia pullata*, C. L. Koch, *Die Arach.*, vol. xv., p. 25, pl. Dxi., 1431—1433.
1861. *Lycosa pullata*, Westr., *Ar. Suec.*, p. 501.
1861. „ *obscura*, Bl., *Spid. G. B. I.*, p. 28, pl. ii., fig. 11; pl. iii., fig. 11.
1872. „ *pullata*, Thor., *Rem. on Syn.*, p. 305.
1876. *Pardosa* „ Sim., *Ar. de France*, vol. iii., p. 332.
1881. *Lycosa* „ Camb., *Spid. Dorset*, p. 376.
1892. „ „ Kulcz., *Ar. Hung.*, vol. i., p. 57, tab. ii., fig. 15.

Length: male, 5 mm.; female, 5·5 mm.

Thoracic bands reddish brown, usually rather obscure: central band narrow, sometimes slightly dilated anteriorly; lateral bands narrow, very near to the margins. Sternum of male blackish brown, often with a narrow band in its fore-part; of female reddish brown, often with an obscure, pale, central band, and, in well-marked specimens, with blackish bars running from the margins, between the coxae, towards the centre. Legs, as a rule, only very obscurely annulated; femora suffused above with black.

This is a very common species and widely distributed in England, Scotland, and Ireland, occurring under all sorts of conditions. On the Continent it is also common, and has an extensive range—North Scandinavia, Spain, Hungary, Russia, etc. Adult from April until September.

Lycosa prativaga, L. Koch, 1870.

(Pl. 2, Fig. 9, *a*, *b*.)

1867. *Lycosa riparia*, Ohl., *Ar. Prov. Preuss.*, p. 134 (*nom. praeoc.*).
1870. „ *prativaga*, L. Koch, *Jahrb. der K. K. Gelehr. Gesell. in Krakau*, p. 43.
1875. „ *riparia*, Camb., *Ann. Mag. N. H.*, ser. 4, vol. xvi., p. 257, pl. viii., fig. 11.
1876. *Pardosa prativaga*, Sim., *Ar. de France*, vol. iii., p. 333.
1881. *Lycosa riparia*, Camb., *Spid. Dorset*, p. 380.
1881. „ *prativaga*, „ „ „ p. 381.
1892. „ „ Kulcz., *Ar. Hung.*, vol. i., p. 57, tab. ii., fig. 16.

Length: male, 5 mm.; female, 5·5 mm.

Thoracic bands yellowish brown, not very distinctly defined, but clothed with very pale yellowish or reddish hairs: central band somewhat dilated behind the eyes; lateral bands irregularly edged, but seldom broken. Sternum usually with a central, pale band in the fore-half, especially in the female. Legs rather strongly annulated in both sexes.

This spider is less common than *L. pullata*, (Oliv.), to which it bears a very strong resemblance. In England it seems restricted to the southern counties, and it is very rare in Ireland. I have no Scotch records. On the Continent this species ranges from Scandinavia to Spain and through Central Europe to Russia.

Lycosa saccata, (Linn.), 1758.

(Pl. 3, Figs. 10, *a*, *b*.)

*1757. *Araneus amentatus*, Clk., *Sv. Spindl.*, p. 96, pl. 4, tab. 8 (*saltem*, fig. 2), (*pre-Linnean*).
*1757. ,, *fumigatus*, Clk., *Sv. Spindl.*, p. 104, pl. 5, tab. 6 (*pre-Linnean*).
1758. *Aranea saccata*, Linn., *Syst. Nat.*, Ed. X., i., p. 623 (*ad partem*).
1763. ,, *lyonetti*, Scop., *Ent. Carn.*, p. 403.
1778. ,, *littoralis*, De Geer., *Mém.*, vii., p. 274, pl. 15, figs. 17—24.
1831. *Lycosa saccata*, Hahn, *Die Arach.*, vol. i., p. 108, tab. xxvii., fig. 81.
1834. ,, *paludicola*, C. L. Koch, *Deuts. Ins.*, 123; 32.
1848. *Leimonia* ,, ,, *Die Arach.*, vol. xv., p. 10, tab. Dvii., 1421, 1422.
1848. *Pardosa saccata*, ,, *Die Arach.*, vol. xv. p. 51, tab. Dxvii., 1451, 1452.
1861. *Lycosa amentata*, Westr., *Ar. Suec.*, p. 496.
1861. ,, *saccata*, Bl., *Spid. G. B. I.*, p. 26, pl. ii., fig. 9; pl. iii., fig. 9.
1872. ,, *amentata*, Thor., *Rem. on Syn.*, p. 298.
1876. *Pardosa* ,, Sim., *Ar. de France*, vol. iii., p. 341.
1877. *Lycosa* ,, Menge, *Preuss. Spin.*, p. 539, pl. 87, tab. 305.

* Clerck's *Svenska Spindlar* being prior to the tenth edition of Linnaeus' *Systema Naturae*, from which all nomenclature is held to date, his names will have to be dropped.

1881. *Lycosa amentata*, Camb., *Spid. Dorset*, p. 370.
1892. ,, ,, Kulcz., *Ar. Hung.*, vol. i., p. 58, tab. ii., fig. 8.

Length: male, 5—6 mm.; female, 6—8 mm.

Thoracic bands yellowish brown; central band broad behind the eyes, then sharply constricted, then abruptly widening again, and finally tapering off to the posterior extremity of the thorax; lateral bands narrow, much broken. Sternum with a narrow, pale band on its fore-part in both sexes. Legs strongly annulated in the female, in all the joints except the tarsi; in the male the femora are strongly suffused with black and sometimes the tibiae are obscurely annulated. Palpus of male densely clothed with coarse black hair.

This is one of our commonest spiders, and occurs in waste ground, amongst rank grass by the sides of roads, on piles of stones and rubbish heaps overgrown with herbage, and in many similar situations throughout the British Isles. On the Continent it has an enormous range, from France to Russia, and from Iceland to Southern Italy. It also occurs in Greenland.

Lycosa nigriceps, Thor., 1856.

(Pl. 3, Figs. 11, *a*, *b*.)

1837. *Lycosa monticola*, Walck., *Ins. Apt.*, i., p. 328 (*ad partem*) (*nom. praeoc.*).
1848. *Pardosa* ,, C. L. Koch, *Die Arach.*, vol. xv., p. 42 (*ad partem*), tab. Dxv., fig. 1445 (*nom. praeoc.*).
1851. *Lycosa saccigera*, Westr., *Goteb. Handl.*, p. 52 (*nom. praeoc.*).
1856. ,, ,, Thor., *Rec. Crit. Aran.*, p. 55 (♂ only) (*nom. praeoc.*).
1856. ,, *nigriceps*, Thor., *Rec. Crit. Aran.*, p. 56 (♀ only).
1861. ,, *saccigera*, Westr., *Ar. Suec.*, p. 483.
1861. ,, *nigriceps*, ,, ,, ,, p. 486.
1871. ,, *congener*, Camb., *Trans. Linn. Soc.*, xxvii., p. 393, pl. 54, no. 1.
1872. ,, *nigriceps*, Thor., *Rem. on Syn.*, p. 283.
1876. *Pardosa* ,, Sim., *Ar. de France*, vol. iii., p. 328.
1879. *Lycosa* ,, Menge, *Preuss. Spin.*, p. 549, pl. 89, tab. 313.
1881. ,, ,, Camb., *Spid. Dorset*, p. 382.

Length: male, 5 mm.; female, 6 mm.

Thoracic bands brownish or greenish yellow: central band very broad in front, then sharply constricted, then, as a rule, more brightly coloured and somewhat attenuated towards its posterior termination; lateral bands broad, unbroken, continued round the front of the caput. Sternum with a pale, central band, and sometimes obscure blackish bars from the margins to near the centre. Legs not annulated; femora in both sexes suffused with black on their upper sides. Palpus of male, tarsus and metatarsus only, supplied with a thick coating of black hairs.

This spider is fairly common, and is widespread in England, Ireland, and Scotland. Its Continental range, however, seems restricted to the north and west. Adult from May to October.

Lycosa lugubris, (Walck.), 1802.

(Pl. 3, Figs. 12, *a*, *b*.)

1775 ? *Aranea dorsalis*, Fabr., *Syst. Ent.*, p. 437.
1802. „ *lugubris*, Walck., *Faune Par.*, ii., 239.
1833. *Lycosa alacris*, C. L. Koch, *Deuts. Ins.*, 120; 17, 18.
1833. „ *sylvicola*, Sund., *Sv. Ak. Handl.*, f. 1832, p. 176.
1836. „ *silvicultrix*, C. L. Koch, *Die Arach.*, vol. iii., p. 25, tab. lxxxii., 182, 183.
1848. *Pardosa alacris*, C. L. Koch, *Die Arach.*, vol. xv., p. 39, tab. Dxiv., 1443, 1444.
1861. *Lycosa silvicola*, Westr., *Ar. Suec.*, p. 474.
1861. „ *lugubris*, Bl., *Spid. G. B. I.*, p. 27, pl. ii., fig. 10; pl. iii., fig. 10.
1872. „ „ Thor., *Rem. on Syn.*, p. 276.
1876. *Pardosa* „ Sim., *Ar. de France*, vol. iii., p. 337.
1879. *Lycosa* „ Menge, *Preuss. Spin.*, p. 548, pl. 89, tab. 312.
1881. „ „ Camb., *Spid. Dorset*, p. 374.
1892. „ „ Kulcz., *Ar. Hung.*, vol. i., p. 58, tab. ii., fig. 9.

Length: male, 5 mm.; female, 7 mm.

Thoracic bands reddish yellow; central band broad throughout its entire length, tapering slightly posteriorly, and, in the male only, thickly clothed with white hairs; lateral bands very narrow and obscure. Sternum reddish brown in the female, darker in the male, in both sexes usually with a short, narrow band in its fore-part. Legs of male brown, the femora being almost black; in the female they are annulated, at any rate the femora.

This is an extremely abundant spider in all parts of the country, but it never seems to occur out of or far away from woods or plantations. The male is a very striking little creature, with his blackish cephalo-thorax and white hairy stripe, as he rushes with wonderful rapidity over the dead leaves, jumping with agility from place to place when pursued. On the Continent, *L. lugubris*, (Walck.), extends from Scandinavia and Russia to Corsica. Adult in spring and summer, and one of the earliest of the genus, being sometimes seen on warm, sunny days in April.

Lycosa annulata, Thor., 1872.

(Pl. 3, Figs. 13, *a*, *b*, and Pl. 4, Fig. F.)

1837. *Lycosa saccata*, Walck., *Ins. Apt.*, i., p. 326 (*nom. praeoc.*).
1872. ,, *annulata*, Thor., *Rem. on Syn.*, p. 299.
1876. *Pardosa hortensis*, Sim., *Ar. de France*, vol. iii., p. 343.
1881. *Lycosa annulata*, Camb., *Spid. Dorset*, 372.
1892. ,, ,, Kulcz., *Ar. Hung.*, vol. i., p. 57, tab. ii., fig. 25.

Length: male, 4·5 mm.; female, 5·5 mm.

Thoracic bands reddish yellow: central band broad behind the eyes (sometimes, especially in the male, the expanded portion is obscure, making it appear at first sight that the band commenced as a point), then strongly constricted, then again enlarging to form a large pear-shaped patch, which tapers to the posterior edge of the thorax; lateral bands rather narrow, usually much broken up, but nevertheless, in the female, continued round the front of the head. Sternum reddish brown, occasionally with an elongate, ill-defined, central, pale patch. Legs strongly annulated in the female; obscurely annulated in the male. Tarsus and tibia of male palpus very dark, patella very pale.

This spider, as far as my records go, is a southern form, but is by no means uncommon. It seems fairly common in Western Europe. Adult in spring and summer.

Lycosa proxima, (C. L. Koch), 1848.

(Pl. 3, Fig. 14.)

1848. *Pardosa proxima*, C. L. Koch, *Die Arach.*, vol. xv., p. 53, tab. Dxvii., 1453, 1454.
1876. ,, ,, Sim., *Ar. de France*, vol. iii., p. 330 (excluding syn. *L. annulata*, Thor.), and vol. iv., pl. xiii., fig. 20.

1881. *Lycosa proxima*, Camb., *Spid. Dorset*, p. 378.
1892. „ „ Kulcz., *Ar. Hung.*, vol. i., tab. ii., fig. 24.

Length: male, 5 mm.; female, 5·5 mm.

Thoracic bands yellowish: central band attenuated both anteriorly and posteriorly, except in some females, where it expands a little behind the eyes; lateral bands well above the margin, obscure in the male, very distinct in the female, sharply broken up into three parts. Sternum with a pale, central band in its fore-part, at least in the female. Legs of female distinctly annulated in the femora, tibiae, and, sometimes, the metatarsi; in the male the femora of the first pair are dark, the remaining femora being irregularly annulated. In brightly marked individuals the annulations extend to the tibiae and even to the metatarsi.

This spider seems to be a southern form, but not by any means common. It has a wide range in Central Europe. Adult in spring and early summer.

Lycosa traillii, Camb., 1873.

(Pl. 4, Figs. 16, *a*, *b*.)

1873. *Lycosa traillii*, Camb., *Trans. Linn. Soc.*, xxviii., p. 524, pl. xlvi., fig. i.
1881. „ „ „ *Spid. Dorset*, p. 545.

Length: male, 6 mm.; female, 7·5 mm.

Thoracic bands very obscure: in the only complete specimen I have seen, a female, the central band was just visible, broad behind the eyes and diminishing but slightly towards its posterior extremity; the lateral bands were represented by several obscure spots. Sternum black. Legs annulated.

This exceedingly rare, but most striking species, structurally, was discovered on the mountains near Braemar, Scotland.

Lycosa fumigata, (Linn.), 1758.

(Pl. 3, Fig. 15.)

1757. *Araneus paludicolus*, Clk., *Sv. Spindl.*, p. 94, pl. 4, tab. 7 (*pre-Linnean*).
1758. *Aranea fumigata*, Linn., *Syst. Nat.*, Ed. X., i., p. 621.
1848. *Leimonia* „ C. L. Koch, *Die Arach.*, vol. xv., p. 16, tab. Dix., 1425, 1426.
1861. *Lycosa paludicola*, Westr., *Ar. Suec.*, p. 499.
1872. „ „ Thor., *Rem. on Syn.*, p. 304.

1876. *Pardosa paludicola*, Sim., *Ar. de France*, vol. iii., p. 348; vol. iv., pl. xiii., figs. 7 and 8.
1877. *Lycosa* „ Menge, *Preuss. Spin.*, p. 541, pl. 87, tab. 306.
1892. „ „ Kulcz., *Ar. Hung.*, vol. i., p. 59, tab. ii., fig. 17.
1902. „ „ Camb., *Proc. Dors. F. Club*, xxiii., p. 29, fig. 12.

Length of female, 9 mm.

Thoracic bands reddish brown: central band broad behind the eyes, then slightly constricted, then enlarged and a little attenuated towards the posterior extremity; lateral bands fairly broad, irregular at the edges, but unbroken. Sternum with a very broad, pale band in the centre of its fore-part. Legs with only a trace of annulation, the femora with black patches above.

An exceedingly rare species in this country, having been found once only, in the Isle of Wight. It has a wide range in Europe, France, Scandinavia, Hungary, etc. I have never had the good fortune to meet with the male.

Lycosa ferruginea, L. Koch, 1870.

1870. *Lycosa ferruginea*, L. Koch, *Jahrb. der K.K. Gelehr. Gesell. in Krakau*, p. 46.
1871. „ *farrenii*, Camb., *Trans. Linn. Soc.*, xxvii., p. 395, pl. 54, no. 2.
1876. „ *blanda*, Sim., *Ar. de France*, vol. iii. (♀ only).
1881. „ *farrenii*, Camb., *Spid. Dorset*, p. 546.
1903. „ „ „ *Proc. Dors. F. Club*, xxiv., p. 160.

Length: male, 5 mm.; female, 6 mm.

The markings of this spider very closely approximate those of *L. saccata*, (Linn.), but the pattern is usually obscure. The tibia of the male palpus is of a tumid form, especially in front. I have not seen *L. farrenii*, but the Rev. O. Pickard-Cambridge, who possesses the type, states (1903, *Proc. Dors. F. Club*, xxiv., p. 160) that he believes *L. ferruginea*, L. Koch, and *L. farrenii*, Camb., to be identical, and that "the latter name has priority in its date of issue." Undoubtedly Mr. Cambridge's paper was read prior to the description of *L. ferruginea* by L. Koch, but does not seem to have been actually published until 1871. This

being so, the name *L. ferruginea*, L. Koch, will have to be retained for the above species.

This rare spider was taken in Cambridgeshire. On the Continent it extends at least from Western France to Hungary.

A careful comparison of the species of *Lycosa* will make it evident that they fall fairly naturally into several groups, not sufficiently distinct, perhaps, for present recognition as genera, but still very useful for practical purposes. Primarily, we can divide them into two sections, which we may call the *L. monticola* section and the *L. saccata* section. In the first the female genitalia consist of a large, very conspicuous, reddish plate, wider behind than in front, and the central process of the male palpal organs is blunt, fairly long, and never slender. In the second section the female genitalia are seldom very prominent, and are never of the reddish tint mentioned above. The central process of the male papal organs is sometimes a long spine, slender and usually sharp-pointed, sometimes simply a small tubercle.

The *L. monticola* section falls into two groups, the *L. monticola* group comprising *L. arenicola*, Camb., *L. agricola*, Thor., *L. agrestis*, Westr., *L. monticola*, Sund., and *L. purbeckensis*, (F. Camb.), in which the posterior angles of the female epigynum are angular; and the *L. herbigrada* group, comprising *L. herbigrada*, Bl., and *L. palustris*, (Linn.), in which the posterior epigynal angles are rounded. In this latter group, also, the males have the tarsi and metatarsi of the first pair of legs somewhat thickened and furnished with numerous erect bristles.

The *L. saccata* section falls also into two groups. In the *L. pullata* group the female epigynum is conspicuous, somewhat diamond-shaped, broader than long, with a strong central septum, and the central process of the male palpal organs is long and slender. This group comprises *L. pullata*, (Oliv.), and *L. prativaga*, L. Koch. The *L. saccata* group, comprising the residue of the species, is not at all sharply defined, and can only be described by negative characteristics—that is to say, its species do not fall under the descriptions of the other groups. Generally speaking, the female organs are more obscure than in the other groups, and the central process of the male palpal organs is of medium length, curved, and sharp-pointed. In *L. annulata*, Thor.,

however, it is reduced to a small tubercle, and in *L. nigriceps*, Thor., it is long and slender, which might lead one to erroneously suppose that this species fell within the *L. pullata* group.

Explanation of Plates 1—4.

In each case the letters *a* and *b* indicate respectively the palpal organs of the male viewed from beneath, the palpus being horizontally extended, and the epigynum of the female. The left palpus of the male is invariably chosen for representation in order to facilitate comparison. Unless otherwise stated the magnification is 50 diameters.

Plate 1.

Fig. 1, *a*, *b*. *Lycosa arenicola*, Camb.
,, 2, *a*, *b*. *L. agricola*, Thor.
,, 3. *L. agrestis*, Westr. Epigynum.
,, 4, *a*, *b*. *L. monticola*, Sund.
,, 5, *a*, *b*. *L. purbeckensis*, (F. Camb.).

Plate 2.

Fig. 6, *a*, *b*. *L. palustris*, (Linn.).
,, 7, *a*, *b*. *L. herbigrada*, Bl.
,, 8, *a*, *b*. *L. pullata*, (Oliv.).
,, 9, *a*, *b*. *L. pratiraga*, L. Koch.

Plate 3.

Fig. 10, *a*, *b*. *L. saccata*, (Linn.).
,, 11, *a*, *b*. *L. nigriceps*, Thor.
,, 12, *a*, *b*. *L. lugubris*, (Walck.).
,, 13, *a*, *b*. *L. annulata*, Thor.
,, 14. *L. proxima*, (C. L. Koch.). Epigynum.
,, 15. *L. fumigata*, (Linn.). Epigynum.

Plate 4.

Fig. 16, *a*, *b*. *L. traillii*, Camb.
,, A. Cephalo-thorax, *L. monticola*, Sund., × 17.
,, B. ,, *L. purbeckensis*, (F. Camb.), × 13.
,, C. ,, *L. herbigrada*, Bl., × 15.
,, D. ,, *L.* ,, ,, var. *intermedia*, nov., × 16.
,, E. ,, *L. palustris*, (Linn.), × 17.
,, F. ,, *L. annulata*, Thor., × 17.

ON THE TAPE-WORMS *HYMENOLEPIS NITIDA*, KRABBE, AND *H. NITIDULANS*, KRABBE.

By T. B. Rosseter, F.R.M.S.

(*Read January 18th*, 1907.)

Plates 5 and 6.

I feel justified in placing, as I have here done, two hitherto uncorroborated species of tape-worms, discovered by Berg and Krabbe respectively, and described and figured by the latter, so far as the armature of the scolex is concerned, in his *Bidrag til Kundskab*, in the genus *Hymenolepis*, Weinland, because, apart from the fact that only in the case of *H. nitida* has the embryo or six-hooked brood been seen, the morphology and physiology of these worms coincide specifically with Dr. Raphael Blanchard's diagnosis of this genus *Hymenolepis*, Weinland (*Hist. Zoo. et Med. des Taeniades du genre* Hymenolepis, *Weinland*, 1891, pp. 48, 49), and are analogous with his type specimen, *H. diminuta*. I have therefore withdrawn them from the Taeniidae and placed them in the genus *Hymenolepis*, Weinland. True, an objection might be raised that in each of the species under consideration the hooks of the rostellum (ten to twenty) are far below the number (twenty-four to thirty) given by Dr. R. Blanchard as characteristic of the genus. Numerically, this objection cannot be sustained, as the genus is divided into two groups, armed and unarmed. Consequently, the armature, whether normally or from caducity, must necessarily vary. Dr. O. von Linstow has taken advantage of this disparity, and placed his new species *H. trifolium*, with ten hooks on the rostellum, in the genus *Hymenolepis*, admitting that the "Eier waren noch nicht entwickelt," thus being able to give us no description of the eggs (*Sonder-abdruck Archiv für Mik. Anat.*, Band 66, 1905). M. M. Kowalewski, too, places his new species of tape-worms—*H. arcuta*, from *Fuligula marila*, and *H. parvula*, from *Anas boschas dom.*—both with ten hooks on their rostellum, in the same genus; but he neither figures nor tells us in the text how many envelopes his

"oval-embryo" in either case possessed (*Extrait du Bulletin de l'Académie des Sciences de Cracovie*); whilst B. H. Ransom (*Studies from Zoo. Lab. Univer. Nebraska, U.S.A.*, 1902) places Conard's new species of tape-worm, from a chicken, with unarmed rostellum but with armed suckers, not in the genus *Davainea* as the armed suckers would indicate, as Conard in his manuscript suggested, and as Magalhaes, who had previously discovered the worm and described it in *Arch. de parasit.*, i., pp. 442—449, had already done, but, its structural resemblance to the type of *Hymenolepis* being so great, in that genus under the name of *Hymenolepis carica* (Magalhaes).

The specimens of *Taenia nitida* that Berg submitted to Krabbe were in every respect perfect specimens, and possessed the oncosphere or six-hooked brood. On Plate 6, fig. 135, Krabbe figures the same, and from his description the oncosphere of *T. nitida* possesses but one individual or single membrane "en enkelt hind"; Plate 5, Fig. 16, is a facsimile of his figure. Now, although in his diagnosis of this genus Blanchard explicitly says that the eggs are "entourés de trois coques très ecartées les unes des autres," still, I do not consider that the fact of the embryo of *T. nitida* being enclosed in but one envelope excludes it from being placed in the genus *Hymenolepis*. It is permissible to suppose that the other membranes of the eggs may have been overlooked by Krabbe in his investigations, from the possibility of the inner or median membrane being closely applied or adherent to the outer envelope, and thus having escaped detection; and the third envelope might have been invisible owing to the embryo filling up the whole of the cell cavity, and possibly from the want of differential staining to discriminate between the plastic substance of the embryo and the enveloping membrane. The first instance, or adhesion of the median membrane, is illustrated in the case of Ransom's oncosphere of *H. megalops* (Nitzsch), where the median envelope is only brought into view by being drawn away from the outer envelope by osmotic pressure. Should such not be the case, and should future investigation of this species demonstrate that the oncosphere does in reality possess but one enveloping membrane, I should be even then, as I am now, of opinion that the possession of three testes and its structural resemblance to the type of *Hymenolepis* justifies *T. nitida* being placed and retained in that genus.

Hymenolepis nitida, Krabbe.

Taenia nitida (Berg, 1867), Krabbe, 1869.
Hymenolepis nitida, Rosseter, 1905.

In December, 1867, in the island of Faroe, Berg found this pretty little tape-worm parasitic in the intestine of the ruff, *Tringa maritima*, and submitted it for examination to Krabbe; who, finding it was a new species, gave it the name of *Taenia nitida*. Berg had the good fortune to secure a perfect specimen, and it is regrettable that Krabbe, in his *Bidrag til Kundskab*,* does not give a delineation of the strobila of this elegant worm. Irrespective of the hooks, however, he has left a landmark, descriptively, to enable the student of helminthology who might find this species of tape-worm destitute of the scolex and hooks to recognise it as *Taenia nitida*, and I shall refer to this peculiarity in the text.

Krabbe's description runs thus: "Longit., 35 mm.; latit., 0·3 mm.; uncinulorum, 10 mm.; corona simplex, quorum longit. 0·11 mm.; aperturae genitalium secundae; hamuli embryonales, longit., 0·013 mm.; habitaculum, *Tringa maritima*." In the text he adds—and this is the only portion of the genitalia he refers to—"Den ovale cirrusblaere er staerkt lysbrydende og derved meget ipinefaldende."

I found this tape-worm parasitic in the golden plover, *Charadrius pluvialis*, L., in December, 1905, and of the ten specimens which I took from the intestine the smallest was 8·1 mm. and the two largest were 14·887 mm. and 10·463 mm. respectively, or three-sevenths smaller than Berg's specimen, and neither of them possessed a scolex, nor had the terminal proglottides matured into uterine segments.

The male genital pore is situated at the extreme dorsal anterior proximal portion of the segment, 0·034 mm. from the lateral border.

The male genitalia are very distinctive in their character. There are three orbicular testes, which in their normal condition are placed equidistant in the posterior portion of the segment—proximally, medially, and distally. In their mature or secretive stage they have a diameter of 0·034 mm. From the proximal testis the vasa-efferentia runs distally along the posterior longitudinal border of the segment until it reaches the distal lateral

* No. 50, p. 294, figs. 133—135.

border; on its way the vas-efferens from the other testes make a junction with it, where their spermatozoa are poured into it. Thence it ascends sinuously, becomes the vas-deferens, and, as such, coalesces with the sperm-sac.

The sperm-sac runs sinuously the whole width, anteriorly, of the segment. In some segments its curvature is very deep, adapting its sinuosity to the formation of the segment. It is very attenuated, having, even when filled to repletion with spermatozoa, a mean diameter of only 0·017 mm. Its proximal end is ampulla-formed and contains the cirrus-pouch, with its attendant cirrus, whilst its distal end curves downward to meet the vas-deferens and terminates in a circular sphincter aperture. This sphincter membrane is an outgrowth of the vas-deferens, and by its contractility and the collapsibility of the sac during coition it effectually closes the aperture, preventing the entrance of an excess of spermatozoa. During coition the sac is completely emptied of its contents, and no more sperm from the testis enters to replenish it.

The cirrus-pouch is claviform, 0·078 mm. long, and contains the cirrus. The cirrus is a long, hollow, flexible rod, adapting itself by its flexibility to the sinuosities of the sac. Distally it resolves itself into a wavy membranous canal—vas-deferens interior—terminating with a circular orifice. From the endoderm of the cirrus-pouch spring a series of protractor and retractor muscles, which attach themselves to the cirrus.

This sperm-sac, with its cirrus and pouch, cannot be considered as a true vesicula seminalis, but rather as an expulsion-bladder, as the spermatozoa are not actually stored here, neither does the distal wavy cirrus membrane swell out—as in some instances the vas-deferens interior does—to form a vesicula seminalis; but, when the long cirrus is everted for the purpose of coition, the spermatic corpuscles pass up the vas-deferens interior, the sac is completely emptied of its contents, and the receptaculum seminis, as the resultant of copulation, is filled with the sperm.

The female genital pore is distinct from, and posterior to, but lies in the same plane as the male pore. The vagina is a beautiful cup-shaped body, resembling in form a miniature water-lily (*Nymphaea alba*). It is composed of a series of bent acicular spines. Its concavity or vestibule is always turned towards the posterior border of the segment, so that one rarely sees the orifice

of the vagina, but only the exterior convexity of the spines. The efferent duct of the vaginal canal is turned towards the expulsion-bladder, hence the cirrus-pouch. In a specimen accidentally crushed, this minute organ was tilted up from its recumbent position, and I was thus enabled to obtain a measurement of the diameter of the orifice—viz. 0·009 mm. This interesting organ—which was apparently unobserved, possibly owing to its minuteness, by both Berg and Krabbe, as the latter makes no reference to it in his text—I consider to be a distinguishing characteristic of the female genitalia in the strobilation of *H. nitida* and *H. nitidulans.* The vaginal canal, on leaving the vagina, runs diagonally upwards ventral of the expulsion-bladder, and makes a junction with the receptaculum seminis. This is a large sub-globular vesicle situated in the middle, somewhat anteriorly, of the segment, and has a diameter, when extended with spermatozoa, of 0·108 mm. In the segment it has the appearance of a light-refracting monocle, and bulges up on either side like a biconvex lens. When the segment is subjected to the influence of carmalum and methyl-blue, although the cellular tissue and the various organs are contrast-stained, this sperm receptaculum, which is but faintly coloured, stands out like a circular pane of coloured glass.

Of the 153 species of avian tape-worms described by Krabbe there are but few instances in which he refers to the cirrus-bladder, and only three in which he describes this organ as being "staerkt lysbrydende," or "strongly refracting the light"—viz. *T. villosa*, *H. nitida*, and *H. nitidulans.* The hooks on the rostellum of *T. villosa* are distinctive of that species, and cannot be mistaken for those of the other two; and, although the cephalic hooks of *H. nitida* and *H. nitidulans* resemble each other in formation, and are numerically the same, yet the contrast in their size (*H. nitida*, 0·11 mm., and *H. nitidulans*, 0·054—0·057 mm.) is so great that it gives to each species a distinctive character. In the present case, in the absence of the scolex and hooks, the "lysbrydende" organ enables me to define this species of tape-worm as Krabbe's *T. nitida*; and, readily as one can understand Krabbe calling it a "lysbrydende" or light-refracting organ, yet he fell into a grievous error in denominating it the cirrus-bladder or pouch, as it is the female and not the male sperm vesicle.

The ovaries are the usual paired organs, situated distally and proximally; the ovarian eggs are contained in semi-lunar pouches. The yelk-gland is oval, and lies in the medio-posterior portion of the segment. The yelk-gland I have been unable to trace, and none of my specimens were sufficiently matured to have developed uterine segments, or for the ova to have passed into the hexacanth stage.

Amongst my specimens was one in which the segments of the strobila differed from the proglottides of the other specimens. In this specimen (Plate 5, Figs. 1—3) the youngest or anterior segments are claviform, and are devoid of rudimentary male organs. These are evolved by growth into a parallelopiped formation, in which the male organs are produced and perfected, as also the "anlage" of the spinous vaginal pore, whilst the following mature hermaphroditic segments are campanulate. In another type specimen (Fig. 4) the anterior segments, which I infer closely follow the scolex and neck—if this is not the actual neck—are three times as broad as long. These are followed by a series of very beautiful infundibuliform proglottides (Figs. 5—7), in which the testis, primarily, and the other male organs are formed and perfected; and these again are resolved into the campanulate hermaphroditic segments, the terminative or primary segment being rounded at its base. It is rare, not only in this but in other species of tape-worms, to find in the terminal or primary segment the hermaphroditic genitalia perfected and fecund.

I consider that the specimen represented in Figs. 1—3 is an abnormal one segmentally, and that Figs. 4—7 show the normal specific specimen. But this abnormality of the proglottides does not destroy its specific individuality, as the anatomy of its generative organs is coincident in every respect with the genitalia of the normal specimen.

Hymenolepis nitidulans, Krabbe.

Taenia nitidulans (Friis, 1869), Krabbe, 1882.
Hymenolepis nitidulans, Rosseter, 1906.

Krabbe, in his *Bidrag til Kundskab om Fuglenes Baendelorme* (p. 7, no. 15, tab. 1, figs. 16, 17), says that Friis found (August, 1869) this tape-worm parasitic in the intestine of *Tringa*

alpina, and the specimens were aggregated together in such numbers that the interior of the intestine had the appearance of a piece of plush. Friis also again found it parasitic in *Charadrius hiaticula*, and in this instance, to quote Krabbe, to the naked eye they resembled an aggregation of crushed oats, groats; but when submitted to the microscope, the granules were found to be young tape-worms, the hooks on the rostellum corresponding with those from *Tringa alpina*. Friis submitted his newly found specimens to Krabbe, who noticed that there were points about the worm which corresponded in some measure with that of Berg's *Taenia nitida*, from *Tringa maritima*, more especially the "cirrusblaeren"—"cirrusblaeren-oval staerkt lysbrydende"; but the hooks of *nitida* negatived it being that species, as the hooks of the worm he had under consideration, although there was and is a great similarity in their structural formation, measured but 0·054—0·057 mm., whilst those of *Taenia nitida* were 0·11 mm. Consequently he formed a new species for this helminth, calling it *Taenia nitidulans*, in contradistinction to *T. nitida*.

Krabbe's description of this pretty little worm is very brief: "Uncinulorum, 10 mm.; corona simplex, quorum longit. 0·054—0·057 mm.; aperturae genitalium secundae; habitaculum, *Tringa alpina*, *Charadrius hiaticula*, in Slesvico (Friis)"—and in the brief text which follows he does not enlighten us more on the external or internal anatomy of the worm.

Von Linstow, 1882, took a tape-worm from *Fuligula cristata* which he thought was the same as *T. nitidulans*; but Krabbe dissented, and thought that the hooks more resembled those of *T. nitida*. Since then, and up to the present time, as far as I am aware, it has not been taken or recorded.

I took this tape-worm from the intestine of a blackbird, *Turdus merula*, in January, 1905. Specimens were fairly numerous, and gregarious in the intestine. The longest was 25 mm., the mature proglottis 0·337 mm. long by 0·844 mm. wide; whilst the smallest was 3·363 mm. long.

The scolex (Plate 6, Fig. 1) is sub-globular, 0·203 mm. in length, and 0·253 mm. in diameter. The four suckers are very weak organs of prehension. The rostrum is pyriform, and is composed of strong retractor and circular muscles, and bears ten sharp-pointed characteristic hooks (Fig. 15), which correspond with

those of Krabbe's *T. nitidulans.* The neck (Plate 6, Fig. 1) is very short, 0·135 mm.; thus strobilisation commences immediately, as it were from the base of the scolex. The composition of the strobila and the formation of the segments will be best understood by reference to the sections of the strobila given in Figs. 2—13, which are a facsimile of those of a type specimen. The organs of generation do not commence to develop until 8·150 mm. of strobila have been budded off from the scolex, and then the median testis appears as a small group of cells.

Both male and female genital pores are situated on the extreme proximal lateral border of the segment, the male anterior to the female, both being raised prominently from the proglottis like two papillae (Figs. 11 and 12).

There are three orbicular testes (Fig. 11, *ttt*), situated medially, proximally, and distally in the segment. They are enclosed in a hyaline membrane which is unaffected by staining, and have a mean diameter of 0·034 mm. The efferent ducts of the proximal and distal testes make a junction with the emerging duct of the median testis, and thus form a common efferent duct, which, running upwards distally and curving round, forms the narrow distal duct of the vesicula seminalis. The vesicula seminalis is a pyriform sac 0·186 mm. long, with a diameter at its rounded end of 0·017 mm., and is situated in the distal anterior portion of the segment. The vas-deferens, which emerges from its proximal end, is short, undulating, and makes a junction with and enters the cirrus-pouch.

The cirrus-pouch (Fig. 11, *cp*) is long and attenuated, its diameter in its swollen or median part being 0·017 mm., whilst its extreme length is 0·185 mm. Its proximal end is elongated into a hollow cone, from the orifice of which the cirrus emerges.

The cirrus is a short spinous rod, 0·034 mm. long and 0·007 mm. in diameter. The spines are but faintly resolved with a $\frac{1}{6}$-in. objective. The distal portion of the cirrus is a long coiled duct, the vas-deferens interior. The pouch is enclosed by a comparatively large oval light-refracting sac (Fig. 11, *pgs*), characteristic of this species, and somewhat analogous to a similar organ in *H. nitida.* Krabbe calls it the "oval-cirrus-blaeren." I have already shown in my description of the genitalia of *H. nitida* the error Krabbe made in denominating it as such, when in reality in that species it is the female recep-

taculum seminis. In this species, *H. nitidulans*, this "staerkt lysbrydende oval-cirrusblaeren" of Krabbe is a muscular glandular sac. The thick, strong, smooth, transparent sagittal muscles of which it is composed run obliquely, longitudinally, and transversely in fascicles interwoven into a net or trelliswork, and one must admit that when the sac is seen *in situ* they might easily be mistaken for spermatozoa. When, however, the sac is ruptured, and the cirrus-pouch is isolated, the illusion is dispelled, and their identity, by the cleavage of the fibrillae, becomes apparent in contradistinction to the spermatozoa, which, when the receptaculum is ruptured, protrude from the vesicle in long, slender, tufted filaments or individuals. This sac is 0·167 mm. long and 0·102 mm. in diameter, but varies somewhat in individual segments, as the longitudinal muscles have a tendency to shorten, whilst the transverse lessen the diameter of the sac. They are totally independent of the muscular structure of the cuticle. This muscular sac contains two prostate glands (Fig. 2). They are semi-lunar, and are developed simultaneously with the secretion of the spermatozoa in the vesicula seminalis. The ducts of these prostate glands run upwards to the apical end of the cirrus-pouch, to which they are attached, and into which they pour their secretion.

In the hermaphroditic segments the female genitalia are ventral to the male. The vagina is cup-shaped; its vaginal canal runs obliquely upwards in the segment crossing the proximal ovary dorsally. It then runs dorsally, curves at its distal extremity, and, running proximally, swells out into a large pyriform sac, the receptaculum seminis (Fig. 12, *rs*). The ovaries are paired organs, but dissimilar (Fig. 12, *oo*), the proximal being elongated, whilst the distal is somewhat rosaceous. The yelk-gland is orbicular (Fig. 12, *yg*), whilst the shell-gland is long and attenuated.

The uterus (Fig. 13) in some of my specimens had not developed, and in those in which it had it was very immature, being only formed at the proximal and distal lateral borders of the segment. In a ruptured uterus which contained impregnated eggs I could trace none which had advanced from the ovarian to the hexacanth stage.

Explanation of Plates 5 and 6.

Plate 5. *Hymenolepis nitida*, Krabbe.

Figs. 1—3. Three sections of strobila (? abnormal), × 70.

,, 4—9. Six sections of strobila (normal): Fig. 4, × 35; Figs. 5—9, × 70 (Fig. 8, male; 9, female).

Male segment: *exb*, expulsion-bladder; *cp*, cirrus-pouch; *c*, cirrus; *vd*, vas-deferens; *ve*, vasa-efferentia; *ttt*, testes.

Female segment: *v*, vagina; *vc*, vaginal canal; *rs*, receptaculum seminis; *oo*, proximal and distal ovaries; *yg*, yelk-gland.

Fig. 10, anterior, and Fig. 11, posterior portion of expulsion-bladder, × 700. Lettering as above; *vdi*, vas-deferens interior.

Figs. 12—14. Spinous vaginal pore, × 700: Fig. 12, *in situ*; Fig. 13, as seen in somewhat crushed segment showing aperture and vestibule of pore; Fig. 14, tilted specimen with emergent vaginal canal.

Fig. 15. Receptaculum seminis—the "cirrusblaeren" of Krabbe— × 140.

,, 16. Oncosphere or six-hooked brood (after Krabbe, × 240).

Plate 6. *Hymenolepis nitidulans*, Krabbe.

Figs. 1—13. Composition of the strobila and formation of the segments, × 70: Fig. 1, scolex with hooks and suckers, neck and early segmentation; Figs. 6—11, development of male genitalia (Fig. 11: *ttt*, testes; *vs*, vesicula seminalis; *vd*, vas-deferens; *pgs*, prostatic glandular sac; *c*, cirrus in act of protrusion from pore; *cp*, cirrus-pouch); Fig. 12, female genitalia (*v*, vagina; *vc*, vaginal canal; *rs*, receptaculum seminis; *oo*, ovaries; *yg* and *sg*, yelk- and shell-glands); Fig. 13, uterine segment.

,, 14. Prostate glands dissected from muscular sac, × 70.

,, 15. Hook from scolex, × 350.

ON THE NATURE OF LIVING ORGANISMS.

By A. E. Hilton.

(*Read January 18th*, 1907.)

The question as to what a living organism really is, in its essential nature, is a singularly difficult one to answer. It is probable, indeed, that a complete answer will not be possible for a long time to come. Yet it is well, now and then, to formulate as far as we can a provisional answer, and to inquire what biology up to date can teach us towards making our notions a little clearer. Unless we do so, much of the suggestiveness of our exhibits and lectures will be largely lost; and the purpose of this paper is to help those whose opportunities for study are but limited.

Science tells us to-day that living organisms are "automatic chemical machines." To those who regard life as a mysterious principle, distinct from, and not inherent in, the material which it animates, this description seems very inadequate. We must remember, however, that science knows nothing of life apart from matter; and that scientific definitions, cut and dried though they be, do but express known facts resting upon unknown causes. Mystery still remains, but nowadays it lies deeper, because the electron theory has made knowledge more penetrative.

That all living things, irrespective of size, colour, form, or habit, have a similar material foundation, has been well known for the last forty years. In a famous lecture delivered in 1868, Huxley described this substance, common to all organisms, as the "physical basis of life." At that time it was called "protoplasm," but now it is more correctly and simply known as "plasm"; and it is this indispensable plasm, the vehicle of all vital activities, which science tells us is "automatic chemical machinery." What we have to do is to grasp the significance of that definition, to convert it into a useful working idea.

The plasm thus defined is a colourless substance, of a jelly-like consistency, neither solid nor fluid. It is about one-half water, by volume or weight. Water, in fact, is the bed or frame of the living machinery, in which the more solid constituents work. In its entirety, plasm is a colloid. It is elastic and highly mobile; but, at the same time, it is tenacious, and not easily diffusible. It is not soluble in an excess of water, and its power of absorbing water is strictly limited; but without a proper proportion of water in its composition, the free action of the vital machinery is impossible.

Microscopists, examining plasm under high powers, have fancied they could detect working parts of the living machinery. Frothy, honeycomb, granular, thread-like appearances have been described, on the supposition that these were characteristic of pure plasm. Such ideas are no longer tenable. The appearances may be those of plasm-products; of the structure of plasm itself they certainly are not, because it is purely a chemical substance, actuated by chemical forces. Disappointing as it may be, we must put aside our microscopes for the present, and pursue our inquiry by the light of the new chemistry.

Formerly, chemical science rested upon the fundamental conceptions of molecules and atoms. Atoms were thought of as ultimate particles of matter, indivisible and indestructible. Molecules were groups of atoms, which could be broken up by chemical processes; but of the affinities which determined the processes no explanation could be given. The new chemistry, which became established about ten years ago, retains the molecular theory, and confirms the atomic structure of matter; but atoms are no longer regarded as ultimate or unalterable. Those attributes have been transferred to electrons, the ultimate particles of electricity, which pervades all substances, living and non-living. Electrons are calculated to be at least one hundred thousand times smaller than the atoms with which they are associated. They are always in swift motion; and the constitution of matter, as now understood, presents to our imagination the surprising spectacle of countless swarms of these tiny missiles, darting in all directions in the spaces between the molecules, colliding,

grappling with, and escaping from each other with inconceivable rapidity, and whirling round the atoms in circular or elliptical orbits. Chemical affinities are now explained as depending upon the quantity of detachable electrons when atoms come into contact; and we are told that in all bodies, rare or dense, including the hardest rocks and metals, the activities of electrons are ceaselessly maintained. We almost begin to wonder, not at the abounding life of nature, but that there should be anything in the universe not alive! Vitality, however, is more than motion: it is movement co-ordinated, and therefore involves processes of particular kinds.

From this necessary digression we return to our study of the plasm. Chemically, it is a compound of compounds, exceedingly complex. Carbon in large proportion, oxygen, hydrogen, and nitrogen in lesser degree, small quantities of phosphorus and sulphur, and traces of some half-dozen other substances, all enter into its composition; but before plasm can be formed from these materials, carbon and oxygen must combine as carbonic acid, hydrogen and oxygen must produce water, and nitrogenous salts must be formed by nitrogen and other elements. Then, by a coming together of these several compounds under natural conditions, plasm results, and exhibits the phenomena of life.

The molecules of plasm are, of course, far beyond the range of microscopic vision; but, comparatively, they are of enormous size. Each molecule probably contains over a thousand atoms; but the atoms are very loosely linked together, and being, therefore, extremely unstable, constantly rearrange themselves in new combinations. Thus the plasm-machinery, intricate as it is, works freely within its limits, and with great adaptability; but it is liable to be affected by every slightest influence, physical, chemical, or electrical.

The opposite but equally important characteristic of plasm is its tenacity. Without firmness, as well as elasticity, it could not build up organic structures; and this firmness is secured by the largely preponderating element of carbon. Organic chemistry is practically the chemistry of carbon compounds; and these we must briefly consider. Carbon, in an almost pure

condition, is found in the form of diamonds. That is significant, but paradoxical. "Life is colloidal," we say; "death is crystallised": yet in a diamond, one of the most perfect crystals, we have the very element most necessary to organic life. The truth is that its power of hard crystallisation, when pure, is an indication of the tenacity with which, although much modified, it holds its own atoms when it forms compounds with other substances. To the highly plastic plasm carbon gives stability, by maintaining the substantial integrity of the molecules when atomic groups of other elements are disintegrated. According to the theory of compound radicals, on which organic chemistry is built up, groups of atoms in the carbon compound molecule may be replaced by groups of other atoms without impairing its general character; and this changeless changeableness is a peculiarly essential quality of sensitive living matter, in which small alterations in arrangements of atoms often produce great differences in properties.

Another feature of carbon which qualifies it for its prominent place in the organism is its desultoriness. Inorganic compounds usually react rapidly and decisively; but under such conditions, life would be impossible. Carbon, on the contrary, is somewhat inert, and combines with other elements in a hesitating, dilatory, rambling kind of way, forming in a wandering fashion innumerable compounds with but few materials, and at the same time largely maintaining its own character. Its power of holding other atoms in various combinations with its own is extraordinary, the compounds of carbon with hydrogen, oxygen, and nitrogen numbering 20,000 at least. These elements are all contained in plasm, in which innumerable changes are constantly going on; but owing to the sluggishness of the carbon, the reactions are often incomplete. Instead of passing on to finality, which would mean death, the processes are arrested, or even reversed, and the vital equilibrium is preserved.

This reversibility of processes which occur in plasm is of great importance. A familiar example of a reversible process is furnished by a jelly, which liquefies when heated, and sets again on cooling; and the illustration is to the point, because there is no

doubt that liquefactions and gelations of the plasm, however caused, play a leading part in the manifestations of life. Alternations of heat and cold, light and darkness, moisture and dryness affect the organism in different ways; and without ready means of readjustment it would suffer, if not perish. The necessary adaptation to environment is accomplished by the vital machinery working automatically in either direction. An oscillating equilibrium of reversible or compensatory processes is maintained, or the life-phenomena fail.

This automatic reversibility of the living mechanism has another important result. It tends to reproduction. It not only saves the individual from premature decease; it also makes for the preservation of the race. Processes of encystment, which are rejuvenescent as well as protective, are commonly reversed processes of development. Reproduction is brought about by some portion of the mature organism reverting to a close approximation of the embryonic substance from which it grew. First structures are simple, rather than complex; and the wonderful fertility of lower organisms is due to the ease with which their plasm reverts to its embryonic state. When reproduction is sexual, it implies that, owing to higher specialisation, the primitive condition cannot be regained except by fusion of sperm- and germ-cells. When that primitive condition is reached, the backward process is arrested, and the ensuing reversal of the machinery causes the development of the offspring.

Probably the most distinctive property of plasm in general is its strongly catalytic character. That, of course, does not entirely distinguish it from lifeless matter, because catalysis is a familar fact, even in inorganic chemistry. It is well known that certain compounds, A and B, which affect each other when in contact, react much more vigorously if, at the same time, a third substance, C, is present; while C, although probably participating in the intermediary stages of the reactions, recovers its identity, and at the end of the process is unaltered. In such cases, C is the catalyser; and it is the possession of this property in a pre-eminent degree which gives plasm its remarkable power of assimilating or modifying the food materials which form its working stock.

Such materials, absorbed in a state of solution, serve partly as nutriment, for the repair or increase of the plasm itself; and partly for the building up of the structure of the organism. Between the tissues and liquids of plants and animals, numberless catalytic processes are constantly going on, producing an endless variety of results; and when the chemical processes are reversible, the catalytic stimulus operates in either direction. In this way, also, the vital balance is preserved, which is so essential to the welfare of the organism.

This brings us back to the electric phase of our subject; because catalysis, like chemical affinity, can only be explained by movements of electrons. It is not true that "electricity is life," because all matter, living or dead, is electric; but all life has electricity for one of its essential elements, and the strength of the vitality of an organism may be gauged by measuring the intensity of the electrical disturbances involved in its changes. On the other hand, when animation is suspended by means of chloroform, the electrical signs of life are also suppressed. All nervous impulses are likewise known to be accompanied by electrical alterations; and here, again, the organism is automatic, because the persistent tendency of its electricity is to re-establish the equipoise between the higher and lower potentials, which is constantly disturbed by occurrences within and without.

The suitability of plasm for utilising, and yet conserving, its electric power is very notable. Complicated carbon compounds are among the best insulators; and as molecules of plasm are comparatively large and loose, multitudes of electrons are effectively imprisoned within them. Pure water, again, is an almost perfect insulator; and water enters largely into the constitution of plasm. Water, moreover, has a remarkable power of splitting up molecules of other bodies into smaller particles, and these particles, diffused through the water, act as "ions"—that is, carriers of electrons. The water in plasm, therefore, is not only a medium for the circulation of food materials and refuse, but, being thus "ionised," it also distributes the electrical energy, while at the same time conserving it. As the speed of "ions" is somewhat retarded in water, the electric energy, although working

freely, is restrained from acting violently; so that, once more, we have the equilibrium necessary to life.

We must now consider some of the products of the "automatic chemical machinery" which has been described. Plasm is by no means a perpetual motion machine, independent of surroundings. On the contrary, unless reinforced from without, it speedily exhausts itself, and either dies or its animation is suspended. It works effectively only so long as it acts as a medium for the intake and output of materials which it absorbs and modifies; and it thrives only so far as those materials are suitable for conversion into addition plasm. or plasm-structures—in other words, for the growth and upbuilding of the organism.

One result of this constant "metabolism," or chemical change of plasm and its working stock, is the production of acids. Now life phenomena only occur in neutral media. Sea water, for example, is practically a neutral fluid; and the liquids in the tissues of plants and animals are also neutral. Acids, therefore, unless counteracted, act as poisons; and organisms would be in perpetual danger of perishing from their own products if their acids were not continually neutralised. There are other products of the plasm-machinery, however, which, by combining with the acids, not only avert the danger, but form salts highly beneficial to the organism, especially in regard to the action of muscles, nerves, or glands. By this means, again, life is preserved in equilibrium.

Other products of the chemical machinery are substances forming the framework by which the plastic plasm builds itself up into definite structures. The machinery operates in two ways. It works up into additional plasm the absorbed materials suitable for growth, and so increases in mass; and it works out of its wheels, so to speak, the substances it cannot utilise in that way, and which would clog its movements if not extruded. This results in precipitations of those substances, away from the central points of activity. Every small mass of plasm consequently forms a film at its surface. The plasm, enclosed in its surface film, may be a nucleus or a free cell. When a larger plasm mass divides up into a number of cells, by reason of forces

which form surface films radiating from numerous catalytic centres, the films which meet combine into firmer membranes; and these, by the continued action of the plasm in depositing fresh material, become consolidated into cell-walls, connective tissues, or the harder bodies which support or protect the various parts of the organism. It is always, however, in the activities of the plasm, not in the strength of the scaffolding it erects, that the vitality of the organism consists. That is a point of the first importance. Not the cell, but the active plasm it contains, is the unit of life.

A point which calls for notice before we sum up is the double advantage of the cell-life of the plasm. The membranes of precipitation which form the cell-walls are semi-permeable; that is to say, they allow some substances to pass through them easily, others not so readily, some only with difficulty, and others not at all. Curiously enough, larger molecules of some substances pass through the cell-walls more easily than smaller molecules of other substances; that is because the permeability depends, not upon the walls being porous or perforated, but upon the degree of solubility, in the membranes, of the substances passing through them. The passage may be in either direction; or an exchange may be going on, some elements passing out of the cells while others are passing into them. The process, a complicated one, is explainable partly by chemical reactions and partly by the more mechanical law of osmosis—the law by which interchanges between fluids of different densities, when divided by membranes, are governed. Usually, the denser medium gains at the expense of the other; and the significance of this in relation to life phenomena is apparent, in view of the colloidal consistency of plasm, its membrane-forming tendency, and watery surroundings. The cells, in fact, serve a double purpose. The permeability of their walls permits the food solutions to circulate through them for the general purpose of sustenance and growth; while the circumstance that the walls are partially impervious enables certain cells, or groups of cells, to develop characteristics differing from the rest. From small differences thus arising, and the operation of the laws of evolution through

long periods of time, have sprung all the bewildering varieties of the teeming life of our planet—the myriad forms which are now extinct, as well as those which are still evolving, including man himself.

In closing with a few general considerations, we may remind ourselves that the goal of experimental biology is still a long way off. Life in its proper sense cannot yet be produced by artificial means from dead matter, notwithstanding sensational announcements which appear from time to time in newspapers. Further, we have no exact definition of plasm; so that we cannot at present formulate a standard of purity. There are doubtless as many atomic arrangements of plasm molecules as there are varieties of organisms. Heredity is caused by chemical processes, under similar conditions, repeating themselves; variations are explainable by changes in molecular constitution, owing to alterations in sex elements or changes in environment. The difference between plant and animal plasm is evidently a deeply seated molecular difference, not yet fathomed. In order of time, plants must have appeared upon the earth before animals, because animals can only manufacture plasm from materials organised from inorganic matter by plants. The animal kingdom is therefore parasitic on the vegetable kingdom, and represents a higher development. The highest developments are found in the nervous and mental functions of the nobler animals, in which plasm conspicuously plays its all-important part.

In conclusion, any attempt to gain a forced clearness in regard to plasm is, of course, only misleading. What is needed is not speculation, but more facts. Therein lies work for the future for all skilled investigators. Meanwhile, our question is, "Can we combine the ideas before us into a practical working notion of the 'automatic chemical machinery' we have been considering?" I think we can. Incomplete as our information is, I believe that in the facts already ascertained we have sufficient materials for a mental model of living matter, which will work well enough to be exceedingly useful, and can be improved as knowledge advances. The construction of such a thought-model requires a mental effort; but the effort is worth

making. Remembering that all things fundamentally consist of plasm, and that the activities of plasm which have been described are mainly concurrent, we have now to realise and hold before our mind's eye :—

1. That plasm is a mobile, restless, unstable, watery colloid, with catalytic properties, growing by assimilation and forming structures by precipitation ;

2. That adaptation to environment, and power of reproduction, are secured by reversible chemical processes ; and

3. That vitality is preserved by an automatic equipoise of forces, maintained in equilibrium by reactions of carbon compounds, neutralisation of acid products, and by active, yet restrained, electrical energies.

If we now combine these features into a single working idea, by a swift and comprehensive act of mental perception, we shall have such a glimpse of the essential character of living matter as will enable us, on reflection, to form a truer conception of physical life, whether manifested in ourselves or in the infinitely varied organisms which abound in nature.

THE PRESIDENT'S ADDRESS.

A REVIEW OF PHOTO-MICROGRAPHY.

BY E. J. SPITTA, F.R.A.S., F.R.M.S.

(*Delivered February 15th*, 1907.)

OWING to the improvements effected in later years in the construction of objectives—more especially, perhaps, those of very high powers—through the introduction of the Jena glass, the reproduction of objects or portions of objects by photography used in conjunction with the microscope has become not only a possibility, but a matter of everyday use for scientific, as well as commercial, purposes. Looking back, it is difficult to be quite certain who really made the first photo-micrograph. In January, 1906, M. A. Nachet, F.R.M.S., presented to the Royal Microscopical Society a frame containing six photo-micrographs taken with the electric light by Leon Foucault with the Daguerreotype process in 1844. The subjects were two of mammalian and one of reptilian blood corpuscles, one of milk, and two of crystals. Each of the silver plates was signed by M. Foucault, and the month and year were also added. The magnification attained in the case of the blood corpuscles was about 500 diameters. This is believed to be the earliest application of the electric light in photo-micrography, although, of course, many photographs with the microscope had been obtained prior to this. For instance, in a work on the Microscope by Lardner, published in 1856, it is stated that in 1845, Dr. Donné, of Paris, published through Messrs. Baillière, of London, an atlas of a course of lectures on "Anatomy and Physiology," which he had given during the previous year, containing twenty plates, each with four reproductions of daguerreotypes made with the aid of the solar microscope. A reproduction

of an early collodion photo-micrograph of the "Proboscis of the Blow-fly" is to be found on Plate VII. of Vol. I. of the *Microscopical Journal* (as the *Royal Microscopical Journal* was then called). This was in the year 1853, and, all things being considered, it was an exceedingly creditable performance, and Mr. J. Delves deserved high commendation for his courage in making the attempt in question. Some years passed before very much work was done, or any real improvement made, although there were several attempts,—the difference between the chemical and visual foci of the objectives being so troublesome on the one hand, while, on the other, their manufacture and computation were so poor, even in the preferred colour for which they were corrected, that, given the overcoming of the focus trouble, the actual image produced on the plate left very much to be desired. This was due to so much outstanding aberration of all kinds, which caused a fogging of the final picture, and one peculiarity was that this fogginess seemed so much more in evidence in the print than when viewing the object by the eye through the same objective. When, however, the genius of Professor Abbe led him to introduce his apochromatic objective, a system so perfected as to bring three colours to actually the same focus, photo-micrography started off with leaps and bounds. The immediate introduction of the semi-apochromatic, with its very perfect image in the preferred colour for which it was corrected and the discovery of the orthochromatic plate, gave still further impetus to the microscopist who desired to photograph his specimens. Several workers now began to make sturdy attempts. Those who succeeded in obtaining really satisfactory photographs made public the results of their labours, and books commenced to appear upon the subject to help those who desired to join their ranks. Perhaps one of the very earliest written was that by a Past President of this Club, Mr. T. Charters White. It was an excellent little book, but it only dealt with low-power work. I well remember having once spoken to Mr. Charters White upon

this point, and he said that he did not believe in high powers; but on my asking "Why not?" replied with a laugh, "Principally because I have not got any." Dr. Bousfield's excellent little manual also appeared, and this has reached a second edition, and has added much to the interest of the subject and to the instruction of those working at it. About this time bacteria began to come very prominently to the front, and Mr. Pringle rose to the occasion and brought out a most instructive little volume dealing almost exclusively with this special department of photo-micrography. Personally, I really think that Mr. Pringle ought to be called the pioneer of bacteriological photography. Dr. van Heurck also added to the literature available by producing a large volume, which, so far as it related to actual photography, dealt more especially with that of the Diatomaceae. Lastly, mention must be made of a little book by Mr. Bagshaw, who in a letter to myself concerning it, said it might be regarded as an attempt to incite those possessed of microscopes to try to use them for photography. A small work it was, it is true, but nevertheless a highly commendable one, and it is a pleasure to know that, growing from such small and comparatively insignificant results, photo-micrography has risen to be quite a little art of itself, and that members have seen in this room photographs, by Mr. A. E. Smith and others, which have enabled those who have not directed their attention to the subject to understand how numerous are its applications to all sorts and conditions of microscopical studies and as a handmaiden to so many of the sciences. One must not fail to note also that the scientific plate-manufacturers have come to the front, especially of late, to help forward the "art" by greatly improving the sensitiveness of the plates and by the manufacturing of contrast screens—notably, perhaps, Dr. Sanger-Shepherd, Dr. Mees (of Messrs. Wratten & Wainwright), Mr. Thorne-Baker (of the Gem Plate Co.), and others whose names I fail to recollect at the moment. Photo-micrography lends itself well to a division into three sections—

low-power, medium, and high-power work, and these can best be shown by a number of lantern photographs, which I shall have great pleasure in exhibiting later. I particularly wish to direct your attention to the fact that for quite low-power work the microscope and the microscopic objective are not required. Indeed, unless the instrument is specially constructed for such work it is not advisable to use it, because the tube cuts down the angle of the objective so very considerably. A first-class anastigmat of about 1-in. focus, such as one of the following—Zeiss Planar, Leitz's new objective, the Beck-Steinheil, and last, but not least, a little gem, computed by a member of our own Club, Mr. A. E. Conrady, with an unusually large flat field—should be attached to an ordinary camera, and the object illuminated in a careful manner, a condenser between the light and the specimen being required in most cases.

[The President then exhibited a long and highly interesting series of photo-micrographs by means of the lantern, explaining in detail their more important points and the apparatus employed in their production. Some further remarks upon this exhibition will be found in the "Proceedings."—Ed.]

WATER-BEARS, OR TARDIGRADA.

By James Murray.

(*Communicated by D. J. Scourfield, March 15th, 1907.*)

Plate 7.

It has been suggested to me by Mr. Scourfield that a short account of the Tardigrada might not be without interest to members of the Quekett Club, and might be a means of inducing some to join the small body of workers in this long-neglected field. As I owe my first introduction to this fascinating group to Mr. Scourfield, I have taken his hint, and tried to give an account of the Water-bears which would be sufficient introduction to the systematic study of the species, while yet no more technical than was inevitable.

At the time when I first met a Water-bear, now some five years ago, and made some sketches of the strange and unknown animal, I was fortunate in making the acquaintance of Mr. Scourfield, who told me to what class the beast belonged. He also informed me that the species I had drawn was unknown in Britain, and that, indeed, Britain was practically an unexplored country, as far as Tardigrada were concerned.

It is an indication of the total neglect of the group up to that time that in those five years the Lake Survey has found about forty species in Scotland, and that many of them are very common. I have since learned, from an early edition of Pritchard (**26**) that some Tardigrada had been found in Scotland not very long after the first published reference to the group, and that shortly before that date (1834) a species had been found in the south of England.

What these bears may have been I cannot learn, as I have been unable to trace the original record. In any case, it is unlikely that the species could be recognised, as it was only in that same year, 1834, that the first nearly adequate description of a Tardigrade was given by Schultze (**40**).

So common are Water-bears that it is surprising that not one

of the excellent observers who did the pioneer work among the Rotifers and Infusoria appears to have seen them before Pastor Goeze in 1773 (**9**), and that for more than half a century afterwards (till 1840) they were considered to be rare, most naturalists who took any notice of them supposing that there was only one kind.

In 1840 Doyère's fine memoir (**2**) appeared, in which Tardigrada were first accurately described and figured, and our knowledge of their organisation greatly extended.

The great advance made by Doyère over all previous observers might have been expected to give an impulse to the study of the Tardigrada, but this was not so. Activity continued to be spasmodic, and works which marked any advance in knowledge of the group appeared at intervals of something like twenty years. It is only necessary to mention Greeff's careful studies (1865-6) (**10, 11**) and Plate's monograph (1885) (**25**).

Plate offers a convenient opportunity for recapitulating what was known of Tardigrada up to that time. He admits six genera and twenty-five species. One of the genera and several of the species cannot be admitted as valid, being either larval states or peculiar (perhaps pathological) conditions of other species. Moreover, Plate's own new species are very inadequately described, compared with Doyère's. On the whole, Plate advanced the knowledge of species but slightly, though his contribution to the knowledge of structure is most valuable.

The only other work calling for remark appearing before the close of the nineteenth century was Scourfield's notes on the Tardigrada of Spitzbergen (1897) (**44**). Unfortunately, Mr. Scourfield limited his work on the Tardigrada to this one effort, and it is matter for regret that he did not turn his attention to the Tardigrada of our own country.

With the year 1900 Richters (**27-37**) appeared in the field, giving a fresh impulse to the study, and first recognising that Water-bears are really pretty numerous. The first of my own papers on the subject (**15-22**) appeared in 1905.

In the following notes on the Tardigrada I have tried to give as much information as will enable the beginner to recognise a Water-bear when found, and to discriminate between different

kinds. After some general hints as to where and how to collect, and how to examine them when found, there follows what I hope is a sufficiently full account of the form and structure of all the genera, with the names of all the external features, and of such of the internal organs as are of service in distinguishing species.

In attempting to recognise microscopic animals described by our predecessors, our greatest difficulty arises from species which are *insufficiently described*. In the case of the pioneer workers this is excusable, as instruments were very imperfect, and they had no idea that species were numerous; but in modern times there is no excuse for some of the very inadequate descriptions which have been given.

It is hoped that these notes will help students by pointing out the characters which must be looked for.

In *Macrobiotus* the claws, pharynx, and teeth must first be studied, then the texture of the skin, any processes, and other peculiarities. Size, colour, and movements should be noted, and whether there are eye-spots.

In *Echiniscus* the number and arrangement of the plates is most important; then the texture and processes, the fringe, the barbs, the palps on first and last legs, etc.

The eggs should be studied whenever possible. To prove the species to which an egg belongs we have to wait for a favourable opportunity; but the hatching of eggs, or even the study of well-grown young in the egg, advances knowledge so much that no opportunity for doing this should be neglected.

As a further assistance all the recognised genera are figured.

Where to find Water-bears.

If one is in the habit of working with what the early microscopists called "infusions" of moss, more especially of moss from trees, it is not likely to be long before certain little animals are seen, which have a striking resemblance to bears, especially when seen from the side. The resemblance is greatest in the feet, with their strongly curved claws, all but the last directed forward; but many kinds have also a sufficiently bear-like head. Along with them may often be seen spherical bodies, covered with small spines or other processes. The bears

often appear to be playing with these spiny balls, holding on to them with the last two pairs of legs and pawing the air (in this case water) in an apparently aimless and more or less violent fashion, as represented in Plate 7, Fig. 1. The animals are Water-bears or Tardigrada, and the spiny objects are their eggs.

They are not confined to tree moss, however, but occur equally among moss from rocks and walls, streams, lake margins, and peat-bogs—indeed, wherever you find moss you may find Water-bears. They are also common among the mud of ponds and even in the dust of gutters, where some of the first were seen.

Method of Collecting.

It is not enough to know the haunts of the Water-bears. If we take the moss, or mud, or dust which we wish to examine for Tardigrada, and put it in water, making an "infusion," we are likely to find the bears; but they may not be in sufficient numbers to serve for study.

To get them in quantity, definite methods of collecting are serviceable, and I will give an account of that which I have found best. It is equally available for obtaining all kinds of microscopic animals which shelter in the axils of moss-leaves.

The moss to be dealt with is put into a conical bag of bolting silk of such a mesh as will allow Water-bears to pass through No. 6 bolting silk, I find, answers very well). A strong stream of water is then made to play upon the moss, in order to wash the microscopic animals out from the axils. As the stream of water passes through this coarse net, carrying Water-bears and similar small objects with it, it is caught below in a much finer silk net (Nos. 17 to 20 bolting silk). The fine sediment collected in this net can easily be transferred to a bottle, after being sufficiently concentrated.

Methods of Observation.

The means of observation to be adopted in order to ascertain the species of Water-bears are simple and easy.

If a drop of sediment, obtained as directed above, is placed on a slide and covered by a slip, it may be examined by a low power of the microscope, in order to find if bears are present. When

found, the low power usually suffices to enable us to determine the genus and also some of the most distinct species.

As a rule, however, a moderately high power will be necessary to see some of the smaller structures by which species are distinguished, and very often the opacity of the animal will prevent the high power being used to any purpose, unless the animal be subjected to some degree of pressure. This cannot be done while the animal is surrounded by débris. The cover-slip must be slid off, the débris cleared off with a brush, and the cover replaced, along with a sufficiently large drop of water to prevent the crushing of the specimen.

The requisite degree of pressure can then be applied by drawing off some of the water with blotting-paper, and when the pressure is just right the animal can be rolled about into any position by touching the edge of the cover-slip. By these means we may see all that is necessary to determine the species.

More elaborate means, such as staining and sectioning, need only be employed when we are going more deeply into the minute structure.

Form and Structure of Tardigrada.

Water-bears are microscopic, elliptical or cylindrical, grub-like animals, varying in size between 1 mm. and $\frac{1}{10}$ mm. ($\frac{1}{25}$ and $\frac{1}{250}$ in.). They are obscurely segmented, have a distinct head, and four pairs of legs, the last pair terminating the body. Each leg bears one or more curved claws, most commonly four in number.

The alimentary system consists of a *mouth* adapted for suction, a pair of stilettiform or lancet-shaped *teeth*, suitable for piercing, which enter the mouth or the throat; a tubular *gullet* leading to the *pharynx*, which is a muscular bulb acting as a pump; an *oesophagus*, leading to the *stomach*; *cloaca*, and *anus*, which opens ventrally, between the third and fourth pairs of legs. Between the skin and the alimentary canal the body-cavity is filled with the body-fluid or blood, in which float large nucleated cells, the fat cells, and sometimes smaller granules.

The central nervous system consists of the brain and four ventral ganglia. There is generally a pair of dark pigment-spots or eyes.

There is a mucus-gland in each foot, and an apical pore connected with it, opening at the end of the foot (see Fig. 9).

The sexes are distinct; but the male and female sexual organs are very similar in appearance. The males are much less numerous than the females.

The skin is frequently shed, and in the majority of species the eggs are laid during the moult, and are left enclosed in the old skin as a protective case. When this is done, the eggs are smooth. In many species of the genus *Macrobiotus* the eggs are laid free of the skin, and such eggs are always covered with spines or tubercles.

The Water-bears possess, in common with the Bdelloid Rotifers, the power of reviving after prolonged desiccation.

They have the further power of withstanding asphyxiation. In the normal healthy, active animal the nerves and muscles can hardly be detected, but in the asphyxiated animal they stand out distinctly. For the study of the internal organisation it is, therefore, desirable to have them in this condition, and it may be easily produced by placing the animals in boiled water and excluding the air by a layer of oil.

Geographical Distribution.

The Tardigrada are what Professor Jennings, in speaking of the Rotifers, calls "potentially cosmopolitan"—that is to say, there is no barrier to their distribution over the greatest distances, and the same species is likely to occur anywhere over the world under similar conditions.

A number of species are of world-wide distribution, being found in the two polar regions and in all the continents.

They do not, however, appear to be so adaptable as Rotifers, and whatever the bar may be to their distribution, many species have a very limited range. This restriction lends interest to the pursuit, as every region has its own peculiar Tardigrade fauna.

Systematic Position.

A few years after Goeze discovered his "Wasserbär," the great Danish naturalist, O. F. Müller, first bestowed a scientific name upon a species, which he called *Acarus ursellus* (**14**). As the

name indicates, Müller regarded the Water-bears as mites, a view of their relationship which is confirmed by the latest researches.

After Müller's time a few naturalists regarded them as insects, but for a long time the crustacean relationship was most favoured. No good reason was ever given for uniting them with insects or Crustacea, rather than with the mites, to some of the lower genera of which they so closely approximate in outward characters at least—the possession of four pairs of legs, and the simple structure, without special organs for respiration or vessels for the circulation of the blood.

The recently discovered encystment of Tardigrada, which was first noticed by Professor Lauterborn (**13**), offers a close parallel to the process observed by Mégnin and Michael in some of the mites of the family Tyroglyphidae (Cheese-mites, etc.), and strengthens the belief in the affinity of the Tardigrada with the Acari.

Encystment.

Many Water-bears of the three principal genera—*Echiniscus*, *Macrobiotus*, and *Diphascon*—have been observed to form *cysts*.

The process begins like an ordinary moult, but the animal does not leave the old skin, but contracts within it till it forms an elliptical body like an egg. This is the cyst. How the outer limbs are got rid of is not understood.

Within the cyst, at any rate in the species which I have studied most (**20**), a simplification of structure takes place, and the animal loses most of its organs and all its hard parts (claws, teeth, pharynx, etc.). The only recognisable parts remaining are the eye-spots, the fat-cells, and some cells with dark contents in the position occupied by the stomach.

The regeneration of the organs has not been seen (though I believe Professor Richters is now studying the process), but I have seen animals emerge from the cysts in a more or less complete condition. They came out backwards, the posterior portion of the case opening like a lid, remaining attached at one point.

The process is strikingly like what Michael observed in the mite *Glycophagus domesticus* (see *British Tyroglyphidae*, Ray Society, 1901, vol. i., pp. 168—173). There was a similar liquefaction of the organs, loss of limbs, and the emergence was likewise by a posterior trap-door.

The mite has a well-marked metamorphosis, and the retrogression by which the cyst is produced takes place in one of the immature stages, and undoubtedly facilitates the distribution of the species. The Water-bear has no metamorphosis, and the cysts appear to be formed after maturity is reached, and do not subserve distribution. It is probably in this case a protection during unfavourable conditions.

The degeneration of the organs during encystment may throw some light on the so-called *simplex* forms. These may be animals which are losing or regaining the organs in connection with encystment, but as simplex forms exist even in the egg, we cannot regard this as a sufficient explanation.

Key to the Genera of Tardigrada.

1.	One claw on each foot	*Lydella.*
	Several claws on each foot	2
2.	Back armour-plated	3
	Back not armour-plated	4
3.	Claws four, in larva two . . .	*Echiniscus.*
	Claws seven to nine (usually eight) .	*Echiniscoides.*
4.	Palps on head, no rods in pharynx .	*Milnesium.*
	No palps on head, rods in pharynx . . .	5
5.	An elongate flexible gullet . . .	*Diphascon.*
	Gullet not elongate and flexible . .	*Macrobiotus.*

Genus **Macrobiotus** Schultze (**40**).

The animals of this genus are narrow and elongate, soft, and obscurely segmented, with no dorsal shields and no palps or bristles on the head. There are four claws on each foot, and they are always associated in two pairs, laxly or firmly united (see Figs. 1, 2, 4, and 9). The claws of each pair are more or less unequal, and the longer one has a bristle or supplementary point behind the principal point (Figs. 7 and 8), or two such points (Fig. 9).

The four principal varieties of claws are figured: (1) the claws join at or near the base only, each pair forming a V with slightly unequal legs, and the two pairs similar (Fig. 2); (2) claws

of each pair closely welded for about half the length of the longer claw, and the two pairs similar (Fig. 9); (3) claws of each pair very unequal, firmly joined at base, the two pairs similar (Figs. 7 and 8); (4) the two pairs dissimilar—one short, nearly equal, and firmly joined, the other with a very long filiform claw, laxly joined to the back of a shorter claw (Fig. 4).

The organs for inbibing food are illustrated in Fig. 5. They are,—a funnel-shaped *mouth*, M; a tubular *gullet*, G; the *teeth*, T; and the *pharynx*, P. The teeth have needle-like or lancet-shaped points, which are seen in the figure entering the mouth. They are greatly enlarged behind, and form there a large *furca*, F (better seen in Fig. 1A). They are supported from the gullet by a pair of sigmoid rods, the *bearers*. They are guided into the mouth by the tooth-sheaths or *guides*, S. The pharynx is a muscular bulb, P, shortly or narrowly elliptical. The gullet passes a short distance into it, and is expanded at the end into a flange. Surrounding the central canal of the pharynx are a number of chitinous bodies, in the form of *rods* or *nuts*, R. These are in six rows, the rows approximated in pairs, and there are two, three, or four rods in each row. The last in each row is commonly smaller, and is called the *comma*, C. Many species have no comma. On the end of the gullet are three processes, called by Doyère the *apophyses* (A), which alternate with the double rows of rods. The two first rods after the gullet are sometimes joined and sometimes free in the same species.

Individuals of *Macrobiotus* are very commonly found which have no rods in the pharynx, and with greatly reduced teeth, or even with no teeth at all, and no gullet or pharynx. These are in a peculiar condition, which I can hardly regard as permanent, the "simplex form" of Richters, the genus *Doyeria* of Plate. Most species are known to have these forms, and they are found even in the egg, but nothing is understood about them.

The skin is usually smooth, but may be papillose (Fig. 2, *M. annulatus*), tubercled (*M. tuberculatus*), or spiny (*M. ornatus*).

The eggs, when laid in the skin at the time of moulting, are smooth and oval; when laid free they are spiny or tubercled, and round, rarely elliptical; in one species only oval and viscous (without spines).

More than thirty species of the genus have been described, and twenty-one of these occur in Britain.

Genus **Diphascon** Plate (Figs. 4 and 6) (**25**).

General form like *Macrobiotus*. Pharynx with chitinous thickenings. Teeth with bearers. Gullet elongate and flexible between the attachment of the bearers and the pharynx, and in some species at least strengthened by a spiral thickening like the tracheae of insects (Richters).

As the gullet in *Macrobiotus* is sometimes found elongate, and as that constitutes the only original generic character of *Diphascon*, the distinction between the two genera is but slight. Professor Richters is also inclined to distrust this genus.

The seven or eight species of *Diphascon* do, however, form a natural group, even if the genus cannot be maintained. While we find in *Macrobiotus* three or four different types of claws, all the known species of *Diphascon* have claws of one type, that found in *Macrobiotus oberhäuseri*. The two pairs of claws are different (see Fig. 4). The larger pair consists of a very long slender claw, laxly connected at the base with the middle of the back of a shorter claw. The shorter pair consists of two nearly equal claws, firmly joined at the base. The longer claws of each pair have supplementary points, as in *Macrobiotus*.

The eggs, so far as known, are smooth, and are laid in the moulted skin. The pharynx may be shortly oval, as in *Macrobiotus*, but in most species it is more elongate than in that genus.

Eight species have been described, and seven of these are found in Britain.

Genus **Milnesium** Doyère (Figs. 14, 15) (**2**).

This very well-marked genus contains only one undoubted species. It is an animal peculiar in every part of its organisation. A circlet of six palps surrounds the mouth, and a little further back on the head are two similar palps. The skin is soft, like *Macrobiotus*, and rather more distinctly segmented. The gullet is very wide, and the teeth and bearers minute. The pharynx is elongate and pyriform, and has none of the chitinous thickenings found in *Macrobiotus*. The claws are very peculiar. There are four on each foot. Two very slender, long, bristle-like claws rise from terminal conical papillae. The lower claws are thicker, and consist each of from one to three hooks.

Two species have been founded on this last character—

M. tardigradum was supposed to have one of the lower claws three-pointed and the other two-pointed; *M. alpigenum* had all the lower claws three-pointed.

The number of points is, however, variable. In Scotland we may find lower claws with one, two, and three points on the same animal. In some other regions they appear to be more constant, and all the examples will have the same number of points (two or three, as the case may be) on the lower claws of all legs.

Genus **Echiniscus** Schultze (Figs. 10—13) (**41**).

The back is covered by a series of plates or shields, symmetrically arranged (as shown in Figs. 10 and 12). There are four small bristles, arising from papillae, near the mouth, and two blunt palps (Fig. 10). At the base of the head is a pair of longer setae (*a*, Fig. 10), usually curved forward and looking very like cows' horns. The teeth are long and straight, and have no bearers. There are generally no rods in the pharynx (doubtfully present in one or two species). There are four claws on each foot (two only in all the larvae known), all free and about equal in size.

The two inner claws of each foot have usually a decurved spine or *barb* on the under surface, while the outer claws have no barb (Fig. 11). Occasionally, the outer claws also have barbs, which are straight, not decurved (Fig. 13). A few species have no barbs on any claws.

The fourth legs have usually a fringe of spines or tooth-like processes, absent from only a few species (Fig. 10, F).

The first leg has, in most species, a small spine (Fig. 12). The fourth leg has in most species a blunt palp at the base (Figs. 10 and 12).

The texture of the plates is characteristic; they may be smooth (rarely), punctate with pellucid dots (of uncertain nature), papillose, pitted, or reticulate with raised lines.

The eggs are always smooth, and are laid in the cast skin.

The body of *Echiniscus* is supposed by Richters to consist of six segments (see Figs. 10 and 12, I.—VI.). The genus is divided into two groups, in one of which segments V. and VI. remain distinct (Fig. 12); in the other, V. and VI. are completely fused together (Fig. 10).

In discriminating species, it must first be ascertained to which group the species belong.

Group I.—The plates are usually twelve in number (or eleven, if segment v. is a single plate, instead of a pair), and are arranged in the following sequence, beginning at the head: Single (I.), single (II.), median (between II. and III.), pair (III.), median (between III. and IV.), pair (IV.), median (between IV. and V.), pair or single (V.), single, large, three-lobed (VI.) (see Fig. 12).

Any of the plates may be subdivided; the median are usually divided into two by a transverse line. In the species figured (*E. mutabilis*) segment II. is often obscurely paired, and the median plates also.

This group, which is thought by Richters to represent the more primitive type of structure, includes only a few species, and only three have been found in Britain.

Group II. (Fig. 10).—The plates are nine (or ten if there is a third median), and the arrangement is always that figured: single (I.), single (II.), median, pair (III.), median, pair (IV.), median (often absent), large three-lobed plate formed by the fusing of V. and VI.

This group contains the great majority of known species, and these are distinguished chiefly by the various dorsal and lateral processes. The commonest processes are five lateral (on each side) and two dorsal, most of which are present on the species figured. The lateral processes are denoted by the letters *a*, *b*, *c*, *d*, *e*. In Fig. 10 the process *e* is absent; when present it is at the slit separating the lateral and median lobes of the large plate (V. + VI.). The commonest dorsal processes are over the lateral processes *c* and *d*.

More than thirty species of *Echiniscus* have been described, and eleven are recorded for Britain.

Genus **Echiniscoides** Plate (**25**).

Distinguished from *Echiniscus* by the more numerous claws—seven to nine on each foot. The genus was founded by Plate as a subgenus of *Echiniscus*. The only species, *E. sigismundi*, was described by Max Schultze as an *Echiniscus* in 1865 (**43**), and, like *Lydella*, is marine.

Genus **Lydella** Dujardin (Fig. 3).

The very minute marine species for which Dujardin formed this genus in 1851 appears to have been seen by no one since its discovery. It is easily distinguished from all other Tardigrada by possessing only one claw on each foot. It has many other peculiarities, and approaches the genus *Macrobiotus* by some characters, but appears to be nearer *Echiniscus*. The long, curved setae on the head, with ear-shaped processes at their bases, and the lateral setae on the body, correspond with structures of *Echiniscus*. The curved teeth, with bearers, and the rods in the pharynx, correspond with *Macrobiotus*. There is a forked bristle on each side of the mouth. The legs are very long and slender, and are distinctly articulated. I can only give a sketch copy of Dujardin's figure (Fig. 3).

Literature.

For the assistance of students it has been thought well to add a bibliographical list which will include all the works in which new species are described. Three-fourths of the works in the appended list (those marked with an asterisk) come under this heading. The others are the more important memoirs dealing with the structure of the Tardigrada.

1. Basse, A. "Beiträge zur Kenntnis des Baues der Tardigraden." *Zeitsch. f. Wiss. Zool.*, lxxx., 1905.

*2. Doyère. "Mémoire sur les Tardigrades." *Ann. sc. nat.*, Sér. II., t. 14, 1840, pp. 269—361.

*3. Dujardin, F. "Mémoire sur un ver parasite . . . sur les Tardigrades, etc." *Ann. sc. nat.*, Sér. II., t. 10, 1838, pp. 181—185.

*4. Ibid. "Sur les Tardigrades, etc." *Ann. sc. nat.*, Sér. III., t. 15, 1851, pp. 160—166.

*5. Ehrenberg. (*Trionychium ursinum*) *Oken's Isis*, 1834, 7 st., p. 710.

*6. Ibid. "Mikrogeologie." Bd. II., Plate 35b.

*7. Ibid. "Beitrag zur Bestimmung des stationären mikroscopischen Lebens in bis 20,000 Fuss Alpenhohe." *Abh. k. Akad. d. Wiss. Berlin*, 1859, p. 429.

8. Eichhorn. "Beiträge zur Naturgeschichte der kleinsten Wasserthiere." Berlin und Stettin, 1781, pp. 74, 75.

9. Goeze. "Der kleine Wasserbär." *Abhandl. aus der Insectologie* (Bonnet), Halle, 1773, p. 367.

10. Greeff, R. "Ueber das Nervensystem der Bärthierchen." *Arch. f. mikr. Anat.*, Bd. I., 1865, p. 101.

*11. Ibid. "Ueber den Bau und die Naturgeschichte der Bärthierchen." *Arch. f. mikr. Anat.*, Bd. II., 1866, pp. 102—131.

12. Lance, D. "Contribution à l'étude anatomique et biologique des Tardigrades." Paris, 1896.

13. Lauterborn, R. "Fauna des Oberrheins und seiner Umgebung." *Verhandl. d. deutsch. Zool. Ges.*, 1906, p. 267.

*14. Müller, O. F. "Das Bärthierchen." *Archiv. der Insectengeschichte* (Fuessly). Zurich, 1785, Heft 6, p. 25.

*15. Murray, J. "The Tardigrada of the Scottish Lochs." *Trans. Roy. Soc. Edin.*, xli., 1905, pp. 677—698.

*16. Ibid. "The Tardigrada of the Forth Valley." *Ann. Scot. Nat. Hist.*, July 1905, pp. 160—164.

*17. Ibid. "Scottish Alpine Tardigrada." *Ann. Scot. Nat. Hist.*, January 1906, pp. 25—30.

*18. Ibid. "Tardigrada of the South Orkneys." *Trans. Roy. Soc. Edin.*, xlv., 1906, pp. 323—334.

*19. Ibid. "Tardigrada of the Forth Valley." *Ann. Scot. Nat. Hist.*, October 1906, pp. 214—217.

*20. Ibid. "The Encystment of *Macrobiotus*." *The Zoologist*, January 1907, pp. 4—11.

*21. Ibid. "Scottish Tardigrada." *Trans. Roy. Soc. Edin.*, xlv., 1907.

*22. Ibid. "Arctic Tardigrada," collected by William S. Bruce. *Trans. Roy. Soc. Edin.*, xlv., 1907.

*23. Packard. "Discovery of a Tardigrade (*Macrobiotus Americanus*)." *Amer. Naturalist*, 1873, vol. vii.

24. Perty. "Einige Bemerkungen über die Familie Xenomorphidae, etc." *Oken's Isis*, 1836, p. 1241.

*25. Plate, L. "Naturgeschichte der Tardigraden." *Zool. Jahrb. Abt. f. Anat. u. Ont.*, Bd. III., Heft 3, 1885, pp. 487—550.

26. PRITCHARD, ANDREW. *The Natural History of Animalcules*, London, 1834, pp. 182, 183.

*27. RICHTERS, F. "Fauna der Umgebung von Frankfurt-a-M." *Ber. d. Senckenbg. Naturf. Ges.*, 1900, p. 40.

*28. IBID. "Fauna ber Umgebung von Frankfurt-a-M." *Ber. d. Senckenbg. Naturf. Ges.*, 1902, pp. 8—14.

*29. IBID. "Neue Moosbewohner." *Ber. d. Senckenbg. Naturf. Ges.*, 1902, pp. 23—25.

*30. IBID. "Nordische Tardigraden." *Zool. Anz.*, xxvii., 1903, pp. 168—172.

31. IBID. "Die Eier der Tardigraden." *Ber. d. Senckenbg. Naturf. Ges.*, 1904, pp. 59—70.

*32. IBID. "*Echiniscus conifer.*" *Ber. d. Senckenbg. Naturf. Ges.*, 1904, pp. 73, 74.

*33. IBID. "Arktische Tardigraden." *Fauna Arctica*, Bd. III., 1904, pp. 495—508.

*34. IBID. "Antarktische Moosfauna." *Verhandl. d. deutsch. Zool. Ges.*, 1904, pp. 236—239.

*35. IBID. "Verbreitung der Tardigraden, etc." *Zool. Anz.*, XXVIII., 1904, pp. 347—352.

*36. IBID. "Isländische Tardigraden." *Zool. Anz.*, xxviii., 1904, pp. 373—377.

*37. IBID. "Zwei neue Echiniscus-Arten." *Zool. Anz.*, xxxi., 1907, pp. 197—202.

*38. SCHAUDINN, F. "Die Tardigraden." *Fauna Arctica*, 1902, Bd. II., pp. 185—196.

*39. SCHRANK. "Fauna Boica," vol. iii., 1804, pp. 178, 179.

*40. SCHULTZE, C. A. S. "*Macrobiotus hufelandii.*" Berlin, 1834.

*41. IBID. "*Echiniscus bellermanni.*" Berlin, 1840.

*42. IBID. "*Echiniscus creplini.*" Greifswald, 1861.

*43. SCHULTZE, M. "*Echiniscus sigismundi.*" *Arch. f. mikr. Anat.*, Bd. I., 1865, p. 428.

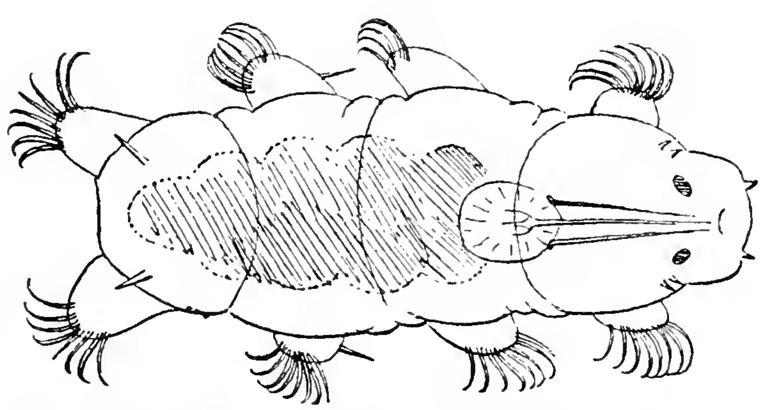
*44. SCOURFIELD, D. J. "Non-marine Fauna of Spitsbergen." *Proc. Zool. Soc. Lond.*, 1897, pp. 790, 791.

45. SPALLANZANI. "Opuscoli di Fisica." Modena, 1776, pp. 181—253.

EXPLANATION OF PLATE 7.

The figures showing the complete animals are drawn to one scale, except Figs. 1 and 3. Fig. 1, *M. dispar*, is such a large animal that it had to be drawn on a smaller scale; and Fig. 3, *Lydella*, is so very small that, to make it visible on a small plate, it had to be drawn on a scale three times as large as any of the others.

Fig. 1. *Macrobiotus dispar* Murray, with its egg, × 150.
„ 1A. *M. dispar*, furca of tooth.
„ 2. *M. annulatus* Murray, × 250.
„ 3. *Lydella dujardini* Plate, copied from Dujardin, × 750.
„ 4. Claws of *Diphascon oculatum* Murray (*oberhäuseri*, type).
„ 5. Diagram of mouth and adjacent organs of *Macrobiotus*: *M*, mouth; *S*, tooth guide; *G*, gullet; *T*, tooth; *F*, furca of tooth; *A*, apophysis; *P*, pharynx; *R*, rods; *C*, comma,
„ 6. *Diphascon chilenense* Plate, × 250.
„ 7. *M. dispar*, claws of first, second, and third legs.
„ 8. *M. dispar*, claws of fourth leg.
„ 9. *M. harmsworthi* Murray, claws.
„ 10. *Echiniscus spitsbergensis* Scourfield. I. to VI., the segments of the body; *a*, *b*, *c*, *d*, lateral setae (*e* absent in this species); *P*, palp on fourth leg: × 250.
„ 11. *E. spitsbergensis*, outer and inner claw.
„ 12. *E. mutabilis* Murray. I. to VI., the segments of the body; *P*, palp on fourth leg: × 250.
„ 13. *E. granulatus* Doyère, outer and inner claws.
„ 14. *Milnesium tardigradum* Doyère, × 250.
„ 15. *M. tardigradum*, claws of one leg.



Echiniscoides sigismundi (copied from M. Schultze).

AN *ALONA* AND A *PLEUROXUS* NEW TO BRITAIN (*A. WELTNERI* KEILHACK, AND *P. DENTICULATUS* BIRGE.)

By D. J. Scourfield, F.Z.S., F.R.M.S.

(*Read March 15th*, 1907.)

Plate 8.

Since the publication of Part I. of my "Synopsis of the Known Species of British Fresh-water Entomostraca," in April, 1903 (see *Journ. Q. M. C.*, vol. 8, p. 431), there have only been, so far as I know, three published records of species of Cladocera new to Britain—namely, *Scapholeberis aurita*, *Ophryoxus gracilis*, and *Alonopsis ambigua*.

The first-named was found by Mr. R. Gurney in Norfolk, and recorded by him in the *Annals and Magazine of Natural History* (vol xii., 1903, p. 630). It was duly noted as British in an appendix to Part III. of the "Synopsis" (*Journ. Q. M. C.*, vol. 9, 1904, p. 40). The second I obtained from Loch Ness, and placed on record in the appendix just referred to (p. 41). The third was discovered by Mr. R. Gurney, again in Norfolk, and recorded in the *Transactions of the Norfolk and Norwich Naturalists' Society*, vol. viii., 1905, p. 59. All three species are figured and described in Lilljeborg's *Cladocera Sueciae*, the work which was taken as the basis of the "Synopsis" so far as the Cladocera were concerned.

I am now able to add two further species to our list, and as neither is mentioned by Lilljeborg, figures and descriptions of them will be given, in order to continue the plan of supple-

menting in a modest way the *Cladocera Sueciae*, and making it available as a complete monograph of the known British species.

Alona weltneri Keilhack.

As long ago as 1895 my friend Dr. T. Scott sent me, from a collection made in a little pool on the Castle Hill at Scarborough, a specimen of an *Alona* which did not agree with any of the species then known to us. As, however, it was closely allied to *A. costata*, and only one specimen had been found, it was not described as a new species, and has, in fact, remained unrecorded until the present time. Upon receiving a copy of L. Keilhack's paper, "Zur Cladocerenfauna des Madüsees in Pommern" (*Archiv für Naturgeschichte*, 71. Jahrgang, 1. Bd., 1905, pp. 138—162), I at once saw that the form therein described as *A. weltneri* (p. 158) was, without much doubt, the same as the dubious *Alona* from Scarborough, a view which is also shared by Herr Keilhack himself, who has very kindly compared tracings of my drawing with his original specimen.

The general appearance of this species is shown in Fig. 1, which is a reproduction of the drawing of the Scarborough specimen made in 1895. (Unfortunately, this specimen has been lost, so that it is impossible to give any further details than those mentioned in this paper.) It will be seen that, as already stated, this species is very nearly related to *A. costata* in all respects except the post-abdomen. The outline of the shell is somewhat quadrangular, but the dorsal line is well arched, and runs into the posterior margin without producing a noticeable angle. The shell-markings consist of longitudinal lines placed at a moderate distance apart. The eye-spot is smaller than the eye, and nearer to the latter than to the tip of the rostrum. The antennules reach almost to the end of the rostrum. The appendage on the labrum is large and well rounded, but slightly truncated posteriorly (Fig. 4). The second antennae (Fig. 3)

appeared to be armed with only seven swimming setae; but as the eighth seta (that on the first joint of the inner ramus), if present, would probably be very short, it may have been overlooked.

Coming to the characteristic post-abdomen (Fig. 2), it will be noticed that, although rather broad at the base, it tapers considerably towards the extremity, and that there is no trace of a posterior dorsal angle, the dorsal margin sweeping round in a fairly bold, even curve to the point where the terminal claws arise. The armature consists of seven or eight teeth, decreasing in size anteriorly. Some of the teeth appeared to be notched or split. Just above the teeth there is a line of exceedingly delicate "scales," each consisting of a few parallel setae.

Keilhack's description and drawing of the armature of the post-abdomen differs somewhat from the foregoing, but not sufficiently, I think, to preclude identification of the two forms. Slight individual variations of the teeth on the post-abdomen are not uncommon among the species of *Alona*, and differences of interpretation by observers working at these fine details of structure under different conditions must also be taken into consideration.

The total length of the specimen figured was $\frac{1}{47}$ in., that of Keilhack's specimen $\frac{1}{50}$ in. (0·5 mm.). *A. costata* is usually a trifle more than this, say $\frac{1}{45}$ in.

Pleuroxus denticulatus Birge.

I obtained this species on August 30th, 1905, from a little pond quite close to the railway station at Exminster, Devonshire. Only a single specimen was seen, and at first I could not be quite certain that it was really *P. denticulatus*, although it was evidently nearer to that species than to any other. Professor Birge, however, has now most kindly sent me examples of the American form, and, after careful comparison, I can see no

reason for doubting the correctness of the identification. The species is a typically American form, and I do not think it has been previously recorded on this side of the Atlantic. It may, therefore, have been recently introduced, and it will be interesting to watch whether it succeeds in establishing itself in this country.

The Devonshire specimen is shown in side view in Fig. 5. In outline it will be seen that it is very similar to *P. aduncus* and *P. trigonellus*; but it differs from those forms by the presence on the shell of evident striae running approximately parallel to the margin on the dorsal part of the head-shield and valves, and also radiating from a central area of the latter to the posterior and ventral margins. Occasionally the striae anastomose, but they never form anything approaching polygonal markings. On the whole, the markings are somewhat similar to those on *P. striatus*. As is usual in this genus, the anterior ventral margins of the valves are provided with little teeth at the bases of the plumose fringing setae. A highly magnified view of these is given in Fig. 7. At the posterior ventral angle there are usually three little teeth; but the number is subject to some variation, even the two sides of the same individual being sometimes different in this respect, as shown in Fig. 6.

The post-abdomen (Fig. 9) is quite characteristic. It differs from what is found in the majority of Pleuroxids in being concave on the dorsal edge instead of straight or slightly convex, although this is a character which is shared with *P. laevis* and *P. striatus*. The post-abdomen in *P. denticulatus*, however, is much broader than in the two last-named species, and it is more decisively truncated at the end, thus forming a sharply marked posterior dorsal angle. The armature also is peculiar, for the first two or three teeth—*i.e.* those at the posterior dorsal angle—are decidedly longer than the rest. Altogether, there are about ten or eleven teeth on each side; but, as is commonly the case in this genus, the teeth of the two rows do not coincide, and, being

very close to one another, they often seem to form one continuous row of nearly double the number occurring on one side alone. This can be seen from Figs. 9 and 10. The teeth as they approach the anus are accompanied by an increasing number of fine setae, and the two anterior ones appear to consist chiefly of such setae, the tooth properly so called being simply the longest and stoutest of the series. On each side of the post-abdomen, just above the teeth, is a line of exceedingly minute setae, arranged, as is usually the case, in a series of curved groups.

Compared with the Devonshire specimen, the American examples exhibit in nearly all cases a distinctly longer rostrum, the tip being rather over than under twice as far from the eye-spot as the latter from the eye. The outline of the shell varies considerably, and in some cases the markings are practically non-existent. There is a marked tendency, although it does not amount to a constant feature, for the posterior dorsal angle of the post-abdomen to be drawn out into an irregular little projection, on which are situated the first two or three teeth. Figures of two American varieties of the species have been given by C. L. Herrick in his *Final Report on the Crustacea of Minnesota* (1884), and again in Herrick and Turner's *Synopsis of the Entomostraca of Minnesota* (1895). I have not been able to refer to the original description by Birge.

The length of the Devonshire specimen is $\frac{1}{45}$ in., and the average size of the American specimens is about the same.

Explanation of Plate 8.

Fig. 1. *Alona weltneri* Keilhack, ♀, × 95.
,, 2. ,, ,, post-abdomen, × 350.
,, 3. ,, ,, second antenna, × 350.
,, 4. ,, ,, process on labrum, × 200.

Fig. 5.	*Pleuroxus denticulatus* Birge, ♀, × 100.	
,, 6.	,, ,,	teeth at posterior ventral angles of valves, × 400.
,, 7.	,, ,,	teeth at bases of plumose fringing hairs on anterior ventral margin of shell × 800.
,, 8.	,, ,,	first antenna, × 500.
,, 9.	,, ,,	post-abdomen, × 310.
,, 10.	,, ,,	dorsal edge of post-abdomen, × 700.

NOTE ON AN EXPANDING STOP FOR DARK-GROUND ILLUMINATION.

BY W. R. TRAVISS.

(*Read December* 21*st*, 1906.)

WORKERS with low powers, who use dark-ground illumination, know that the best effects are obtained by the use of a set of "spots" or a graduated cone, by which the size of the "spot" can be adjusted until that which gives the desired result is obtained. When changing powers this causes a waste of time. Diaphragm aperture can be controlled to a nicety by the well-known Iris diaphragm, and an expanding spot working on the same principle would complete the apparatus. I propose to explain in this paper as simply as possible how an amateur may make such an expanding spot for himself. A lathe is not necessary, the following tools and materials being all that are required—a small table vice, a pair of spring dividers, a pair of sharp nippers, a few so-called Swiss "needle" files, a broach No. 62, and "Eagle" drills No. 7; two dozen or so of ordinary fine toilet-pins, some hard roll sheet brass about 0·04 in. thick, and some "sheave metal" about ·005 in. thick. The files, which should be 10 cm. flat-pointed, can be obtained from the dealers in watchmaker's tools, and the brass from the well-known merchants in Clerkenwell.

I shall explain the geometry of the apparatus on a large scale, leaving the worker to choose a size for himself, simply remarking that a disc 0·4 in. in diameter is about the size which will suit the ordinary Abbe condenser.

Let Fig. 1 represent a circle, within which a concentric circle is drawn as close to the edge as may be, so that the holes to be drilled on this inner circle shall not break through. The first thing to be done is to divide this circle into ten or twelve equal parts—the larger the number of divisions the rounder will be the expanding spot. There are limits, however, to the number of divisions, as will be seen later. Two or more of these circles should be made from the 0·04 sheet brass, for use as templates or as a stand-by.

Now, taking a drill of a size that will make a hole which will

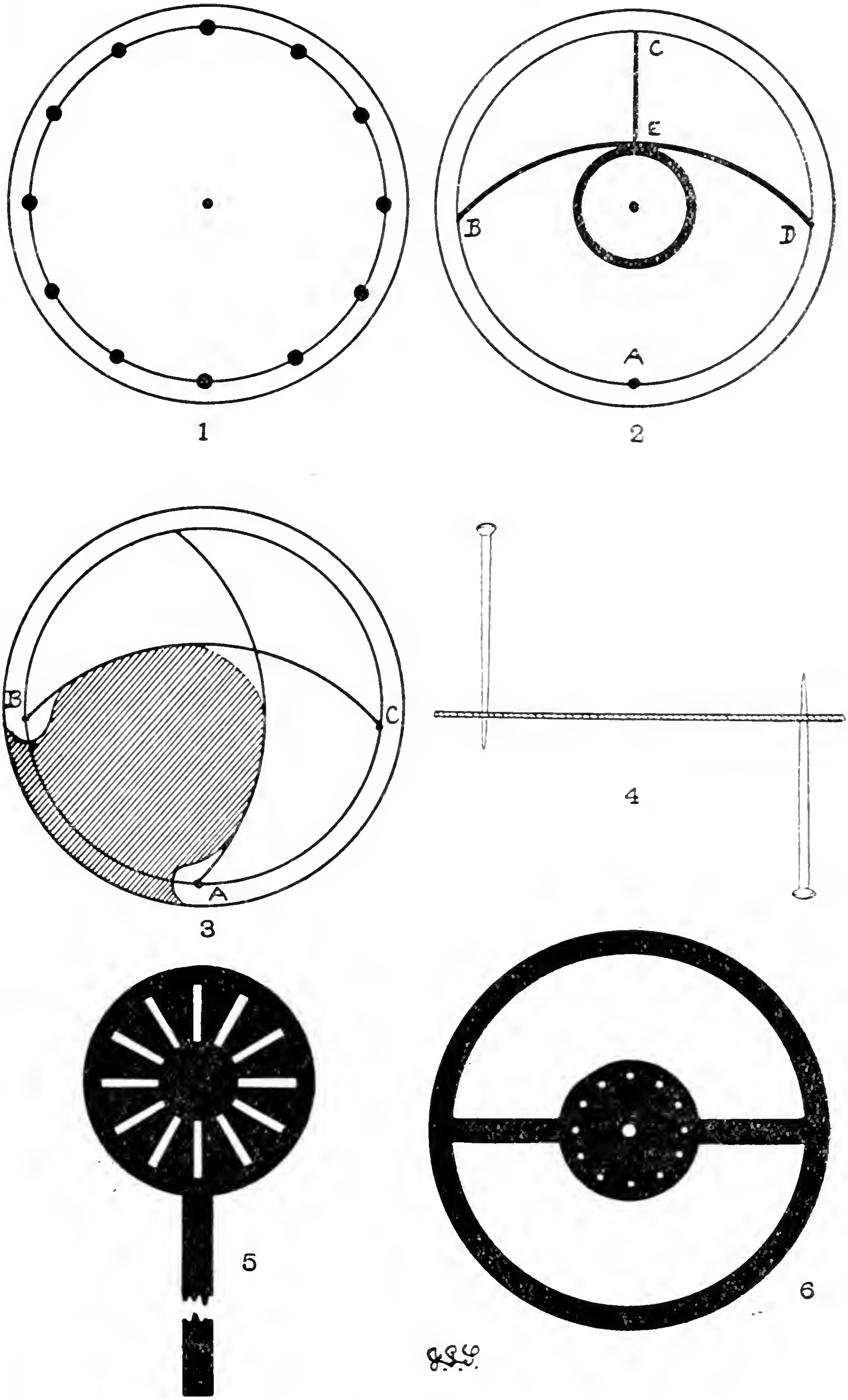
just fit the full points of the pins that are to be used (if the hole is so large that the pin will slip through up to the head it is too big, as the pins will then quickly work loose), drill all the holes and set the plate aside as No. 1 template (Fig. 1).

Cut another circle from the same metal the same size as No. 1, with concentric circle as before. Taking any point A on this latter circle, set your dividers so as to scribe the arc BD *beyond* the centre, in order to give room for the pivot, and for other reasons which will appear later. Drill the holes at A and B and also the centre, and we have template No. 2 (Fig. 2).

Now take the metal for the sheaves. If the dividers are made sharp at the points, and are held firmly on the metal, which should be laid on a piece of flat, hard wood—*e.g.* mahogany—by turning the metal round several times under them, it will be so nearly cut through that by carefully buckling the brass it will break clean away. If the disc itself is found to be buckled, lay it on a flat iron plate and *rub* the face of the hammer gently over it to flatten it. Make a dozen or more of these discs. Now take template No. 2, and with a pin put through the centre of one of the thin discs, put it on the top and knock it into the mahogany block just so that it will hold. Take another pin and drive it carefully into A, and leave both pins there until you have knocked a third pin into B. One having been done, all may be taken out and the rest finished in the same way.

In order to obtain the pattern of a sheave, set the dividers to scribe a circle from the centre A, with a radius such that the arc BC shall pass above the centre of the disc as shown in Fig. 3. Now, keeping the dividers set as before, scribe another arc cutting the arc BC, and, leaving enough metal round the points or holes A and B, and rounding the angle of intersection of the arc as shown, cut away the shaded portion with a pair of small sharp scissors. The piece which is left is a sheave of the proper pattern.

In order to pin the sheaves the pin must be gently forced into the small holes A and B, one in each face of the circle: they must be kept upright and square to the face. Take a strip of blowpipe solder, flatten it out with the hammer, and cut it into tiny strips; these curl up, but can be easily straightened. Use salammoniac dissolved in water as a flux, a pointed match to put it on with, and a wing feather as a brush. Heat them over a very small



Figs. 1—6.

spirit-flame or a gas-flame turned down to a small blue light. Take the sheaves with the pins in one by one, try how little salammoniac you can use, and when the sheave is getting of a reddish colour, not red-hot, touch it with the tip of one of the thin, hair-like strips of solder. If overdone, brush off the excess with the feather, and with a little practice this can be done very neatly (Fig. 4). Next nip off each pin close to the top so that there is now one headless pin pointing up and one down. Take a piece of metal of the 0·04 gauge, drill a hole in it, and clamp it in the vice. Let the hole be made to just free the pins. Now put each pin through this hole, nip off close to the brass, and with a small, fine, smooth file take off the sharp edge left by the nippers. If a slight burr is raised on the pin, it can easily be forced out with a sharp point. It must on no account be pulled through, or the sheave will be bent, and it is most important that it should be quite flat with a pin on each side. Having made a dozen or more in this way, we can now go on to the next step.

If a sheave is made to pivot in the plate used as a template (Fig. 2) at A, and moved round it from B to D, the pin B, when at E, will be at the nearest point to the centre, and the distance from C to E will be the length of the slot (to be presently described) for the upper plate. Now take a disc of 0·04 brass, and using Fig. 1 as template, mark off all the holes round the edge at regular intervals; then scribe a circle from the centre to E, Fig. 2, and draw radii from the centre to each hole as accurately as possible. Drill holes at C and E that will just allow the pin to pass and no more. Drill a series of such holes along the line of the radius from C to E as close together as possible, and then, with a very fine needle file, break through the metal between, so as to convert the line of holes into a slot, Fig. 5. Two or three files may be required before the plate is completed, unless they are very carefully used, as the tips break very easily. The slot is finally smoothed out with the flat part of the file. When all the slots are cut, see that a pin passes freely up and down them. The action of one sheave can now be shown by passing a pin through the centre, having one sheave in Fig. 1, and then putting the plate, Fig. 5, on the top; holding the lower one between the fingers of one hand and twisting with two fingers of the other, it will be seen whether it clears the slot at E. The reason for a limit to the number of sheaves and the distance at which the arc

is to be scribed from the centre (Fig. 2) will now be more or less clear. If there were too many sheaves and the slots were too near together at the centre, they would break into one another and spoil the whole thing. This point should be well considered before starting to make the apparatus, though, of course, the greater the number of sheaves the rounder the spot will be.

If there are many sheaves, do not scribe the arc quite so near the centre the smaller the number of sheaves the nearer to the centre may the arc be scribed. The spot will always expand to a maximum, but with a very small number of sheaves the circle is not very true. It would be as well to make paper models, to see exactly what happens at varying distances from the centre.

Having prepared all the necessary pieces, the whole may now be put together, starting from any hole. Lay a sheave on the plate, with the pivot-pin in the hole of the lower plate (Fig. 1). Nos. 2 and 3 will go on easily, but No. 4 will have to be put in by lifting up B of No. 1 and so on, adjusting each under No. 1 till the whole are in their places: this can be done with the aid of a sharp needle. When all are in place, take the slot-plate (Fig. 5) and drop it very carefully over the whole, getting as many pins into their proper slots as possible, and placing the rest by the use of the needle. This done, pass a pin through the centre, and the working of the apparatus may be tested. No force must be used, for it should open and close very easily. The most troublesome part of the work is now over.

The next thing requiring consideration is how the apparatus is to be mounted, whether on a stem or on a stop fitting into the spot-carrier. Cut a circle of 0·04 in. brass to fit the spot-carrier; scribe a circle in the centre of the size of the template Fig. 1. Drill a small hole in the centre, and prick off and drill all the other holes; then, with a fret-saw, cut away the metal as shown in Fig. 6, leaving two bars to support the centre-piece. This will now act as the lower plate; the sheaves are put in, the slotted plate on the top, and the thing is done. All that is now required is a lever of proper length to move the upper plate and expand the sheaves. One small matter, however, must not be forgotten—viz. a "steady-pin" notch on the edge of the large stop, and a pin in the shoulder of the spot-carrier to prevent the whole from turning bodily when moving the lever.

The lever and slotted plate should be made in one piece, as Fig. 5, with a screw tapped into one plate, tight, and to "clear" in the other. Sufficient play must be allowed to give the sheaves room when closed. The apparatus being now complete, the next process is to black it. This can easily be done as follows:—Put a small piece of copper wire into nitric acid, and let it remain until the solution is a decided green. Add to it a little water. By way of trial, take a bit of clean scrap brass and dip it into the solution; then pass it to and fro through a small flame (gas or spirit-lamp) until the flame ceases to be coloured green. As the sheaves are very small and thin, care must be taken in the "burning off" not to get them too hot. This done, brush all the parts lightly with an old tooth-brush which has been rubbed on a piece of stove blacklead two or three times. The holes and slots may be cleaned out afterwards with a pointed match. See that the sheaves are flat, and now put the whole thing together for the last time.

There are many ways in which the sheaves may be blackened. If it is found that the pins become loose by the acid process, I would advise the use of some of the "dull black" varnishes such as are on the market, or dissolve a small piece of shellac in alcohol and mix a little lamp- or gas-black with it, painting it on the sheaves, etc., with a soft camel-hair brush, and then gently warm them. Do not, however, make the black too thick.

NOTE ON NEW DIATOM STRUCTURE.

By A. A. C. Eliot Merlin, F.R.M.S.

(*Read December 21st, 1906.*)

I have lately effected the following resolutions of diatomic structure which I believe to be new, and may prove of interest.

Melosira clavigera, Grun., var.; Oamaru.

The hyaline silex centre of this form is covered with a very beautiful lacework which, although it cannot be described as easy, would probably yield to a really good objective of N.A. 1·3 with critical axial illumination. I have completely resolved it with the Zeiss $\frac{1}{8}$-in. apochromat of N.A. 1·42, and full cone of Powell's dry apochromatic condenser used in conjunction with Gifford's blue-green glass and methyl-green screen. A specimen of the normal *M. clavigera* from the same locality shows fainter perforations of a like kind.

Melosira marina, Kutz; Oamaru.

The centre of this diatom exhibits similar structure to the above, but finer.

Melosira biseriata? Oamaru.

Möller places a note of interrogation after the species of this form. It has an extremely delicate network pattern all over the large central hyaline area. It is much more difficult than the preceding forms, but has been completely resolved with N.A. 1·42 and a large solid axial cone. The *M. clavigera* and *M. marina* should be examined first, as it would be quite useless to expect any optical arrangement which failed on them to succeed with the *M. biseriata.* These remarks, however, should be taken as only strictly applying to the specimens actually examined, it being quite possible that some examples of the species referred to may be found to vary and possess coarser structure.

With reference to my paper read January 19th, 1900 (*Q. M. C. Journal,* Second Series, vol. 7, p. 295), in which I stated that the faint secondaries seen on the upper surface of the hyaline

bands of certain *Navicula lyra* might be possibly "false ghosts," the probable reality of the structure in question seems to be indicated by recent observations on a *N. amphisbaena* Bory., on the extensive clear central area of which apparently true, fine, *very* difficult secondaries have been detected. In connection with this subject I may mention that my friend Mr. Nelson lately wrote to me that, with a solid axial illuminating cone of N.A. 1·3 from an oil-immersion condenser, he has caught a glimpse of a similar veil over the valve of *Navicula rhomboides*. This veil has since been seen by me on other specimens of *N. rhomboides*, with a cone of only about N.A. 0·95.

Melosira westii, W. Smith; Oamaru.

This has a fairly regular perforated structure all over the central area. It is more obvious than that on the other species of the genus yet examined, and should be well within the grasp of any good oil-immersion objective.

Hyalodiscus maximus, Ehrb; Oamaru.

This diatom exhibits practically identical structure of about similar fineness* on two different focal planes, the valve being apparently made up of two parallel, closely perforated plates. The distance separating the focal planes of these two distinct structural layers is only $\frac{1}{6000}$ in.

Two other unnamed species of *Hyalodiscus*, from the same deposit, show most distinct and unmistakably true double structure of the kind all over the large central area of the discs, the focal planes being respectively $\frac{1}{3000}$ and $\frac{1}{4000}$ in. apart. These measurements were effected with the fine adjustment of Powell's No. 1 stand and $\frac{1}{8}$-in. apochromat by focussing up from the lower to the upper plate of each form, and represent the intervals between the sharply imaged structure on the two layers.

Of five different specimens of *Hyalodiscus* mounted on an Oamaru type slide, Möller is only able to give the species of one, so that more precise indications cannot be furnished; but there seems little doubt that most, if not all, the valves of this genus are similarly built up of two plates.

* This would not be so in the case of a false diffraction ghost, where, with an over-corrected objective, the upper structure would appear of double the fineness of the lower.

Auliscus oamaruensis, G. & S.

The process caps appear as translucent siliceous bubbles covered with a most delicate perforated network, of the type discovered by Mr. Nelson on *A. sculptus*.

Auliscus fenestratus, G. & S.; Oamaru.

The small process caps of this very beautiful form are finely perforated. It is probably the most difficult of all the varieties of *Auliscus*, and is a severe test for the finest high-angled apochromats.

Coscinodiscus oculus iridis, E.

I have succeeded in obtaining a glimpse of the secondaries on the outer surface crowning the hexagonal framework of this form, which much resemble those of *C. asteromphalus* in general arrangement, except that the areolations forming the periphery of the rings are very small, and the inner perforations appear to run in parallel lines; but this latter feature may possibly merely be the effect of insufficient optical power.

All the above-mentioned specimens were examined in styrax.

Triceratium cancellatum, Grev. (*pseudo nervatum*); Oamaru.

Exhibits a faint veil of difficult secondaries all over the upper surface of valve.

Triceratium americanum, var.; Oamaru.

Has similar fine structure to the above.

It has been found that diatomic structure of the kind described in this note is usually best observed with a 12 ocular used in conjunction with the $\frac{1}{8}$-in. aprochromat. The images are generally so excessively faint that no objective yet made will afford sufficient contrast on them to render deep eye-pieces advantageous. It must, of course, be borne in mind that mere closeness of structure is not always necessarily the cause of faint rendering with the best objectives, as perforations in a tenuous transparent siliceous film may well afford so little contrast, with transmitted light, as to be scarcely visible, although they may be sufficiently widely spaced to lie well within the separating power

of the lens. In many cases, however, even on diatoms, where minute details happen to be sufficiently contrasted, a deep eye-piece will be found both serviceable and necessary, and the wisdom of employing objectives of high optical index is manifest, for their magnifying power can be easily varied by means of the eye-piece to suit different objects.

With regard to this question of magnification, I have prepared dark-ground photographs of two different forms of *Triceratium novae zealandicae,* × 490 (although both specimens are so named by Möller, one example is double the size of the other). These photographs were taken with a Zeiss 16-mm. apochromatic objective, of measured N.A. 0·35 (really a ½-in., its measured initial magnifying power on the 10-in. tube being × 18), and a Powell 26-projection ocular. The focus was in both cases adjusted on the images of the sub-stage apochromatic condenser stop formed in the centre areolations, and the single bar arm of the central stop is plainly pictured in many areolations of both specimens. I venture to think that you may agree with me that the scale of the photographs, for the aperture used, is by no means too great when this bar is the object sought for, and that there is really no useless over-magnification.

Doubtless the bar could be detected on a smaller-scale picture when its existence is once known; but if it were not especially sought for, the chances of accidentally overlooking it would be greatly increased were less power employed. Now, the 1-in. apochromat of N.A. 0·32 would require the 40 eye-piece to visually yield a magnification of 400—a ratio of less power to aperture than that of the photographs. The negatives were taken with the nominal 16 mm., instead of the 24 mm., for the reason that sufficient camera extension was not available to obtain the required enlargement with the latter lens, even with a 26-projection ocular. I should add that, visually, the stop and bar images appeared sharper and blacker than in the photographs, which were secured by means of a ½-in. lamp-flame and Nelson's aplanatic doublet auxiliary condenser. No screen was employed, as even without one an exposure of an hour for each plate proved barely sufficient.

NOTICES OF BOOKS.

An Outline of the Natural History of our Shores. By Joseph Sinel. $7\frac{3}{4} \times 5$. xvi. + 345 pages. 123 illustrations. London, 1906. Swan, Sonnenschein & Co., Ltd. Price 7*s.* 6*d.*

A popularly written handbook, dealing in a practical and reasonably scientific manner with the commoner denizens of our shores, is sure to find favour with a large number of those intelligent observers who make a visit to the seaside an opportunity for the observation of a few of the myriad wonders of the ocean. Commencing with the lowest forms in the scale of animal life, the author takes us step by step through all the more important groups, touching upon many points of interest concerning some of the commoner species included in each of them. Last, but not least, are some general chapters upon such subjects as Coloration, Mimicry, Collecting, Preserving, and the Making of Microscopic Preparations, and so forth. The marine aquarium at home is dealt with in a brief but very practical manner, and the tyro is not asked to believe, as is often the case, that the keeping of sea-beasts in captivity is a matter of supreme simplicity. We are rather surprised to find that no mention is made of that very simple and effective piece of apparatus, particularly well adapted to the aeration of small tanks, which consists of a slender tube carrying water, which, in its course, entraps large bubbles of air and delivers them in rapid succession at the bottom of the aquarium. This apparatus may be seen in operation at the Horniman Museum, at Forest Hill; and I believe that our member, Mr. W. Gardner, who has actually succeeded in breeding sea-anemones in small glass vessels, adopts a similar device.

Generally speaking, the illustrations are good; but the plate of Foraminifera has, unfortunately, failed to properly reproduce the reference numbers, and a few of the photographs, although perhaps taken under trying conditions, fail to convey a really satisfactory idea of the object represented—such, for example, as fig. 88, and the egg-cases in fig. 89. In one or two instances the lists of objects represented in the plates might have received a little more attention in the matter of spelling.

The author seems to have tripped in his description of a

method of making type slides, in stating that, when numbering the backgrounds for reduction by photography, "Note must also be taken to write the figures 'reversedly,' for the microscope reverses the images." If the figures are normally written on the prepared card the negative reverses and the print puts matters right again. But the ordinary compound microscope not only reverses from right to left—it inverts also; and so, if the figures are correct on the print, they are equally correct when viewed with the microscope, the slip being, of course, placed so to allow for the inversion.

On the whole, we can warmly recommend this little work to the notice of those who are at all interested, or have any desire to be interested, in the subjects with which it deals. F. P. S.

THE METRIC AND ENGLISH WEIGHTS AND MEASURES. By P. E. Radley. $4\frac{3}{4} \times 3\frac{1}{2}$. 64 pages. London, 1907. Published by the Author, 30, Theobald's Road, W.C. Price One Penny.

The extensive adoption of the Metric System in optics and chemistry, largely due, no doubt, to the great strides which have been made of late in these and kindred sciences by Continental investigators, has made it a matter of necessity for the serious worker to more or less acquaint himself with the decimal method of calculation. We note, therefore, with pleasure, the appearance of this unpretentious but extremely useful little book, which cannot fail to find favour in the rôle of a time-saver with every one engaged upon work where the necessity arises for the conversion of the Continental weights and measures into those generally employed in this country, and *vice versa*. For the practical man, facilitated methods for rapid approximate comparisons are given; but the requirements of the most exacting are catered for, inasmuch as the important standards are compared to the extent of sixteen or more places of decimals. We hope that this little work will meet with the success it deserves. F. P. S.

ELEMENTARY MICROSCOPY. By a clerical error the price of this work, reviewed in the last number of the Journal, was stated to be 2*s*., whereas it should have been 3*s*. F. P. S.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

AT the meeting of the Club held on October 19th, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on June 15th were read and confirmed.

Mr. H. Taverner, F.R.M.S., exhibited and described a special form of filter-bottle which he had found very convenient for the filtering of volatile mounting media. Messrs. W. Watson & Sons exhibited the following instruments, which were described by Mr. T. J. Smith:

1. A simplified form of metallurgical microscope, built on the Student's type, the special feature being the stage, which is furnished with a rack-and-pinion adjustment for focussing.
2. A sliding-bar for microscope stage, fitted with hardened steel ball-bearings.
3. A Darlaston-Cathcart microtome, fitted with automatic raising action to the object-holder.
4. A turn-table, with ball-bearing centre.

Mr. Rousselet, F.R.M.S., read a "Note on *Tetramastix opoliensis*," giving a corrected description and figure of this rare Rotifer. A specimen of the creature was exhibited, the peculiar characteristics being very clearly shown.

Mr. J. Burton read a paper "On the Reproduction of Mosses and Ferns," illustrated by a number of coloured drawings and preparations beneath microscopes.

At the meeting of the Club held on November 16th, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on October 19th were read and confirmed.

Messrs. J. Elliot, E. H. Roberts, L. Miles, F. R. Mallet, S. P. Stephens, B. P. Collins, W. Crosbie, E. E. Price, E. O'Brien,

W. J. Hocking, and Dr. D. J. Reid were balloted for and duly elected members of the Club.

Mr. F. P. Smith contributed a paper, which was taken as read, on "The British Spiders of the Genus *Lycosa*."

Mr. F. P. Smith delivered a lecture on "Vagabond Spiders." After some words of introduction, the lecturer said he would confine his remarks to a few of the commoner British species. The term "vagabond" simply meant "wandering," and although most spiders wander to some extent, it is possible with but little difficulty to separate those which are true wanderers without home at all. It was not claimed that the spiders now included as "vagabonds" formed anything like a strictly natural group; but the title was a convenient one, and one whose purport could be easily understood and remembered. The three principal groups of Vagabond Spiders in this country—in fact, in the whole world—were represented by the typical families Lycosidae (Wolf-spiders), Thomisidae (Crab-spiders), and Salticidae (Leaping Spiders). All the spiders included in these groups were true wanderers, making no snare of any kind, but capturing their prey and eluding their enemies by various combinations of stealth, speed, power of endurance and cunning. These remarks were intended to apply to female spiders only, as the males of all species were more or less vagabonds when adult, the females compensating for this by being almost invariably rogues, treating their suitors and husbands in the most shameful manner. The Lycosidae and their allies are admirably constructed for running, their legs being long and rather stout, tapering considerably to the extremities. The name "Wolf-spider" is a very apt one, for the majority of the species are of various shades of brown, and are thickly covered with hair. In favourable situations, too, individuals are often so plentiful that they might be supposed to be gregarious; but, as a matter of fact, there seems to be no advantage gained by this sociability, except, perhaps, that in seasons of scarcity the weaker may serve to appease the appetites of the stronger. In many of the Lycosid species the female carries the egg-sac about with her, attached to the spinners, and the young, when hatched, are borne for some time upon the back of the mother, giving her the appearance of being covered with a thick mass of pale fungoid growth. The egg-sac is composed of two hemispheres fastened together by a band of silk. The

hind-legs of the female rest upon this band, and as the young emerge they crawl up and down the mother's legs, helped by the long spines. Mr. Smith gave an amusing account of a notable habitat of this spider—namely, the East London dustheaps at Edmonton, where he had found it very abundant. The decomposing sardine-tins, for instance, attract many bluebottles, and there we find also many spiders. After a few remarks upon the spiders included in the genus *Pirata*, which are able to run upon the surface of water, and reference to *Dolomedes*, belonging to a closely allied family, which actually constructs rafts of dried leaves and fragments of twigs, upon which considerable excursions are made, the lecturer went on to speak of the second group of Vagabonds, the Crab-spiders. These are characterised by a peculiar articulation of the legs, enabling the creatures to travel with equal facility forwards, sideways, or even backwards. While the spiders of the first group run, many of those included in this second group may be said to waddle; but they waddle sometimes very quickly, and their speed, combined with the erratic character of their movements, renders them very difficult objects to capture. Some interesting lantern-slides were exhibited of a spider, *Oxyptila atomaria*, belonging to this group, illustrating the habit of travelling through the air by the aid of gossamer ribbons. The spider climbs to the top of a reed, and when the wind is in the right direction, puts out a small ribbon of web-material. This the wind blows out. The creature then cuts the web away from the reed and sails through the air for some distance; then drops to the ground, climbs another reed, and repeats the process over and over again. The spider is able, to a considerable extent, to control the length of its journeys, as, if it wishes to drop, it pulls in some of the ribbon of gossamer, and rolls it up between its legs, and if it wishes to prolong its journey more web-material is given out. The third group of Vagabonds—the Salticidae, or Leaping, Hunting, or Jumping Spiders, as they have been called—form a very extensive family, far more strongly represented in the tropics than in this country. We have, however, some thirty-three species recorded as British, and the habits of such as have been studied are of extreme interest. The lecturer gave a short description of the more striking characteristics of the Salticids, mentioning also some of the more interesting habits

and curious incidents connected with these spiders, and concluded by announcing his willingness to assist any one who might think of seriously taking up the subject of these much-neglected Arachnids. Among the slides exhibited were a number of "portraits" of spiders taken by means of a specially designed apparatus, and showing the "face" view of the subject, thus producing, not only a striking effect, but demonstrating clearly the arrangement of the eyes. *Lycosa amentata* was shown carrying its egg-sac and attacking a blow-fly. The Crab-spiders (Thomisidae) were well represented by various species of *Xysticus* and *Oxyptila*, a portrait being also shown of *Misumena vatia*, a spider which hides in flowers in wait for bees and other insects. A number of slides of Salticidae (Jumping Spiders) were also shown, terminating by a series illustrating in five scenes the attack upon and capture of a house-fly by *Marpessa muscosa*.

The President remarked upon the very large attendance at the Club, and stated that the number present was the highest on record.

At the meeting of the Club held on December 21st, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on November 16th were read and confirmed.

Messrs. C. S. Perrin, W. G. Cullen, H. W. H. Darlaston, H. H. Fawcett, E. H. Ruscoe, A. E. H. Pinch, L. Mornay, A. G. Scoter, J. H. Melady, and C. J. Hasstacher were balloted for and duly elected members of the Club.

The death, on November 22nd last, was announced of Mr. Edward Jaques, B.A. Mr. Jaques was one of the twelve founders of the Club. He was the Club's first Librarian, serving in that capacity from July, 1867, to 1872. Only two of the founders still survive—Mr. W. M. Bywater, F.R.M.S., and Mr. M. C. Cooke, M.A., etc.

Mr. Henry Morland having resigned his office as Hon. Treasurer, which he has held for the last seven years, it was announced that his successor, Mr. F. J. Perks, of 48, Grove Park, Denmark Hill, would receive all subscriptions, etc., due to the Club on and after January 1st, 1907. On the motion of the President, a vote of thanks, which was duly acknowledged, was accorded to Mr. Morland for his past services.

Mr. W. R. Traviss exhibited and gave a description, illustrated by aid of blackboard diagrams, of an expanding central stop for dark-ground illumination. The device proved of considerable interest to members present.

The Hon. Secretary read a "Note on New Diatom Structure," communicated by Mr. A. A. C. Eliot Merlin, F.R.M.S.

Mr. A. E. Conrady did not think the magnification quoted of the photographs excessive on the numerical aperture employed, although, if taken much further, the image, to keen eyes at least, would soon become "fluffy." The ratio quoted—say one thousand times the N.A.—corresponded pretty closely with the employment by astronomers of a power of 50 to the inch of telescope aperture; and, although under very good conditions it would occasionally be possible to use 75 or even 100 to the inch, if one went beyond such a ratio, say to the equivalent of 2,000 times the N.A. of a microscope objective, we should not see anything we could not see better with less magnification, although we might be able to see something quite new, which, however, would not belong to the object!

Mr. Morland said he did not often use high powers on diatoms. His principal object was to show the form of a species. He thought that, occasionally at least, the extremely fine markings of these organisms must be obliterated by the heroic methods adopted in cleaning.

Mr. Earland asked why it should be expected that diatoms of the same species—or book species—should always have to contain the same number of markings to the millimetre. We did not find elsewhere in nature that markings were absolutely constant in number and character. It seemed that if a diatomist found a specimen with a few more striations to the micron than usual, he promptly made it a new species.

The President, in moving the adoption of a vote of thanks to Mr. Merlin for his paper, said they all knew that that gentleman had exceptionally keen eyesight. He suggested the exceptional keenness might possibly be due to some physical peculiarity in the structure of the eye, particularly so when regard was had to the fact, as he understood, that Mr. Merlin always used a screen in observing visually. The limit of visibility to the unassisted eye was usually given as $\frac{1}{250}$ in.; but he thought that very few indeed had eyesight equal to this.

At the meeting of the Club held on January 18th, 1907, the Right Hon. Sir Ford North, F.R.S., Vice-President, in the Chair, the minutes of the meeting held on December 21st, 1906, were read and confirmed.

Mr. T. B. Rosseter, F.R.M.S., communicated a highly technical paper on two avian tape-worms, *Hymenolepis nitida* and *H. nitidulans.*

Mr. A. E. Hilton read a paper "On the Nature of Living Organisms."

The Hon. Secretary said that biological chemists had as yet added nothing to the work of working biologists, and in many cases their theories do not accord with well-acknowledged facts. Especially was this true with regard to certain statements made regarding the Foraminifera. Reference was made to Butschli's work on Foams; but it had been shown that the very interesting movements observed were purely due to chemical reactions. Regarding the question of the making of life as a possibility of the near future, he quite agreed with a recent statement by Sir Oliver Lodge to the effect that he did not expect to see life made in his time, and he would add that he thought such a thing quite impossible.

After some remarks by Mr. J. T. Holder on the difference in the character of the plasm of the nucleus, and by Mr. T. J. Edwards on reversibility of processes, Mr. Nevill thought the electron theory much more difficult to accept than the atomic theory. The atomic theory was difficult enough to understand, but it at least agreed with observed facts, especially with regard to the prediction of discovery of new elements. But, as regards the electron theory, he thought one might say that it was created by mathematicians to get out of difficulties, without any one being much wiser by the result. Respecting the origin of life, he thought it was the general opinion that beyond the ordinary constitution of matter something more is needed to account for the wonderful things we see around us in the organic world. Referring to the reversibility of processes, the speaker instanced the case in the development of the blow-fly, where, during the pupal stages, the whole organism reverts to the egg-state, and the perfect insect grows anew from the semi-liquid contents of the pupa-case. He thought there must be some intelligent power behind mere matter.

Mr. Hilton, in reply, said he agreed with the remarks by their Hon. Secretary, but at the same time he thought that it was just as well to know what scientists were attempting to teach us. He did not suppose that the meeting would accept *all* the points mentioned. His paper, he hoped, gave a fair representation of the average statement of the most advanced science workers of the present time, and he was quite aware that biology furnished some of the most contentious subjects of the day. He thought that if members referred to the presidential address of Professor Gotch at the last meeting of the British Association, they would find what he considered a sufficient justification for the paper he had just read. Personally, he did not think that life would be artificially created in the laboratory in his time; more he would not say. In reply to the question, he said he regarded nuclei as the most active centres of catalytic action. The electron theory was, of course, pure speculation, and personally he would be very sorry to lose molecules and atoms, which were like old friends.

At the meeting of the Club held on February 15th, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on January 18th were read and confirmed.

Messrs. H. G. Mumford, A. C. Dilks, and C. A. Newman were balloted for and duly elected members of the Club.

The President having appointed Messrs. Dennis and Taverner as Scrutineers, the ballot was taken for the election of Officers and Committee nominated at the previous meeting.

Whilst the ballot was proceeding the President said he felt it was incumbent upon him to make a remark upon the serious loss they were about to sustain by the retirement of Mr. Earland from the secretaryship of the Club. No one knew better than the President how much Mr. Earland had done for them, and he believed he was correct in saying that he only now regretfully retired, upon the advice of his doctor, who feared the result of the continued strain after his recent illness. He hoped that Mr. Earland's mantle might fall upon his successor, who had been well known to them for some years past as an active member of the Club. He thought they ought not to let the occasion pass without giving to Mr. Earland their most hearty

thanks for his past services, and their sincere wishes that he might soon be restored to perfect health.

The proposal was carried by prolonged acclamation.

The Secretary read the 41st Annual Report of the Club.

The Treasurer read the Statement of Accounts and audited Balance Sheet for the year 1906.

The adoption of the Report and Balance Sheet, having been moved by Mr. Webb and seconded by Mr. Dick, was put to the meeting by the President and unanimously carried.

The Scrutineers having handed in their report of the result of the ballot, the following gentlemen were declared duly elected as the Officers and Committee for the ensuing year:—

President	E. J. Spitta, L.R.C.P., M.R.C.S., F.R.A.S., F.R.M.S.
Vice-Presidents.	The Rt. Hon. Sir Ford North, F.R.S. G. C. Karop, M.R.C.S., F.R.M.S. C. F. Rousselet, F.R.M.S. Henry Morland.
Treasurer	Frederick J. Perks.
Secretary	W. B. Stokes.
Assistant Secretary . .	J. H. Pledge.
Foreign Secretary . .	C. F. Rousselet, F.R.M.S.
Reporter	R. T. Lewis, F.R.M.S.
Librarian	Alpheus Smith.
Curator	C. J. Sidwell.
Editor	Frank P. Smith.
Five Members of Committee.	J. Rheinberg. C. D. Soar. D. J. Scourfield. W. J. Marshall. A. Earland.

A list of presentations made to the Club during the past year was read. Among the most noteworthy may be mentioned a large number of very fine serial sections of the various stages of the Blow-fly, made and presented by the late Brigade-Surgeon J. B. Scriven, and a collection of twenty-two type slides of Rhizopoda and allied Protozoa, presented by Dr. Eugène Penard, of Geneva, who was elected an honorary member of the Club during the past

year. The report presented by the Excursions Sub-committee was also very satisfactory.

The President then delivered his annual address, taking for his subject "A Review of Photo-micrography." Some fifty lantern photographs were exhibited. Among the more noteworthy may be mentioned a photograph of a sprig of *Spirea*, followed by another of more advanced growth, taken without shifting the camera, illustrating an interesting application of the subject to a scientific examination of the microscopical growth of plants; a number of photographs taken with low powers, some of whole insects, showing the extreme flatness of field possessed by some of the special objectives referred to in the address; proboscis of blow-fly photographed with an achromat of the highest quality, used with a screen, followed by one of the same preparation taken with a modern apochromat; several slides of bacteria, some with and some without the use of a contrast screen, exhibiting the great advantage obtained by the use of such a screen in the case of faintly stained preparations; and, in conclusion, a series of eight photographs of *Amphipleura pellucida*—the first of an entire valve showing lines from end to end (the lines number some 98,000 to the inch), others showing this diatom in dots taken with blue light by the use of a special apparatus designed by the President, the magnification on the screen being more than 60,000 diameters (nearly 3,000 on the original).

After the usual votes of thanks to the President for his address, and to the various Officers of the Club, and to members of the Committee for their services during the past year, the meeting, which was extremely well attended, adjourned.

OBITUARY NOTICE.

EDWARD JAQUES, B.A.

Born, September 12th, 1825 *; joined the Quekett Club on its foundation in* 1865 *; served on Committee,* 1865–7 *; first Honorary Librarian,* 1867–72 *; died, November 22nd,* 1906.

By the death of the late Mr. Jaques another gap is made in the now rapidly diminishing list of the Club's founders. Of the twelve gentlemen who, on June 14th, 1865, attended the meeting held at 192, Piccadilly, in the office of Mr. Robert Hardwicke, the publisher of *Science Gossip*, only two survive — viz. the veteran microscopist, Dr. M. C. Cooke, and Mr. W. M. Bywater, who was the first Honorary Secretary of the Club. At this preliminary meeting Mr. Jaques moved the appointment of a provisional committee of five gentlemen to report on the best means of carrying out the object of the meeting, which, it appears from the original minute-book, was "to establish a society of amateur microscopists based on economic principles." He also took part in the adjourned meeting, held on July 7th, 1865, in the National Schoolroom at St. Martin's-in-the-Fields, which saw the actual foundation of our Club; and on August 4th, 1865, he was elected a member of the first Committee, subsequently becoming the first Librarian. After his resignation of this office in July, 1872, he does not appear to have taken any active part in the management of the Club, but he was a frequent attendant at the meetings until quite recent years.

Edward Jaques was a son of the late John Jaques, a solicitor of Ely Place, and after graduating at London University was articled to one of his father's partners, and admitted a solicitor in 1851. A few years later he entered the Civil Service as a

clerk in H.M. Office of Woods and Forests, retiring in 1892. A man of wide reading and varied tastes, he had many interests outside microscopy. Social problems had a special fascination for him. For over thirty years he was an ardent supporter of the total abstinence cause, and during the latter part of his life he devoted much time to the work of the Salvation Army, to which he had been attracted at a time when it required no little courage for a man in Mr. Jaques' position to avow himself a supporter of that cause. Of broad sympathies and singularly benevolent disposition, he will be missed and affectionately remembered by a wide circle of friends.

FORTY-FIRST ANNUAL REPORT.

In presenting their forty-first Annual Report your Committee is again able to congratulate the members on an improvement in the Club's position.

During the twelve months ending December 31st last, fifty-seven ordinary members and one honorary member—viz. Dr. Eugène Penard, of Geneva—were elected. This number compares well with the forty-eight elected in the previous twelve months and with the decennial average, which is forty-one. During the year, however, twenty-two members were lost by resignation and five were removed for nonpayment of subscriptions. Nine members died during the same period, amongst whom were Mr. J. J. Vezey, a Vice-President and former Treasurer of the Club, an obituary notice of whom appeared in the April Journal; Mr. Edward Jaques, B.A., who was one of the twelve original members of the Club and its first Librarian; Mr. Duncan S. Miller, who was a familiar figure at the Club until a short time since; and Mr. E. Larmer, who will be remembered as one of the most regular exhibitors on "gossip" nights.

The total number of members on the books of the Club on December 31st, 1906, was 414, as against 402 in 1905 and 382 in 1904, thus showing a continuous and satisfactory increase.

The attendance both on "gossip" nights and at the ordinary meetings continues to be extremely large, and there has been no appreciable falling off in the character of the exhibits, though, perhaps, the number of exhibitors shows a tendency to decrease, due to the death or removal from London of certain regular exhibitors. This is a matter which will doubtless adjust itself as their places are filled by other members, but your Committee think it desirable to draw attention to the fact, as they recognise that the success of the Club is largely bound up with the interest of the "gossip" nights, which, again, are dependent on the efforts of the exhibitors. Members working in special fields of research

should bear in mind that objects which are of everyday occurrence in their experience are frequently more or less unknown to many of their associates, and would be fully appreciated if exhibited together with a brief explanatory notice.

The principal communications read at the meetings during the year were as follows :—

Jan.	On *Drepanidotaenia undulata* (Krabbe)	Mr. T. B. Rosseter.
,,	On a New Tape-worm, *Drepanidotaenia sagitta* . . .	Mr. T. B. Rosseter.
Feb.	President's Address. The Relative Merits of the Long- and Short-tube Microscopes . .	Dr. E. J. Spitta.
March.	Observations on the Life History of the Hydrachnidae . .	Mr. C. D. Soar.
April.	The Spiders of the *Diplocephalus* Group	Mr. F. P. Smith.
,,	The Literature of the Sub-family Erigoninae . . .	Mr. F. P. Smith.
,,	Note on a New Finder . .	Mr. J. M. Coon.
,,	A Simple Method of taking Stereo-photo-micrographs . . .	Mr. H. Taverner.
,,	A Simple Method of producing Stereo-photo-micrographs .	Mr. W. P. Dollman.
,,	On Stereoscopic Effect and a Suggested Improvement in Binocular Microscopes . .	Mr. J. Rheinberg.
May.	Note on Stereo-photo-micrography	Mr. A. E. Smith.
,,	Mendelism and Microscopy . .	Mr. D. J. Scourfield.
June.	On the Study of the Mycetozoa .	Mr. A. E. Hilton.
Oct.	Note on *Tetramastix opoliensis* (Zacharias)	Mr. C. F. Rousselet.
,,	On the Reproduction of Mosses and Ferns	Mr. J. Burton.
Nov.	The British Spiders of the Genus *Lycosa*	Mr. F. P. Smith.
Dec.	Note on New Diatom Structure .	Mr. A. A. C. Eliot Merlin.

In addition the following lectures were delivered :—

Jan.	The Senses of Insects . . .	Mr. R. T. Lewis.
Nov.	Vagabond Spiders . . .	Mr. F. P. Smith.

The Committee desires to thank the lecturers and those gentlemen who have contributed their researches to the Club.

During the year the Journal has appeared at its regular times, and has been considerably increased in size and in illustrations. The cost is accordingly much greater than has been considered advisable for several years past, and is again as high as would be warranted by the increased membership. It is hoped, however, that it will be possible to maintain the present rate of expenditure, as the Journal appeals especially to the country and foreign members, and is in considerable demand as an exchange with other societies both at home and abroad.

With the cordial support of some of the principal members of the trade, six demonstrations on the practical use of the microscope and its accessories were arranged for the current session. Three demonstrations have already been given which have been highly appreciated, and have attracted an unusually large attendance of members and visitors. It is obvious that such demonstrations entail much time and labour in their preparation, not to mention the use of much valuable apparatus, and the cordial thanks of the members are accordingly due to Messrs. H. F. Angus, F. W. Watson Baker, F.R.M.S., Conrad Beck, F.R.M.S., and C. Lees Curties, F.R.M.S., for the trouble which they have so willingly undertaken for the benefit of the Club.

The Hon. Librarian reports that there has been a steady and constant demand for books. There is no doubt that the Library is one of the most valuable assets of the Club, and that the privilege of borrowing works of reference on subjects which lie outside the scope of most other libraries is keenly appreciated, and attracts many members who might not otherwise join the Club. The educational facilities which the Club's Library and Cabinets have afforded to the thousands of individuals who have made use of them since the Club was founded can hardly be overestimated.

The additions to the Library during the year were :—

Jackson (B. D.), *Glossary of Botanic Terms.*

Webb (W. M.) & Sillem (C.), *The British Wood-lice.*

Chamberlain (C. J.), *Methods in Plant Histology.*

Hasluck (P. N.), *Microscope and Accessories and How to make them.*

Witt (G. N.), *Simbirsk Diatoms.*

Ormerod (E. A.), *On Injurious Insects of South Africa.*

Forbes (E.), *Monograph of the British Naked-eyed Medusae.*

Martin (J. H.), *Manual of Microscopic Mounting.*

Murray (Jas.), *On New Species of Rotifers, etc.*

Penard (E.) { *Les Héliozoaires d'eau douce.*
Faune Rhizopodique du Bassin du Léman.

Massee (G.), *Text-Book of Fungi.*

Scales (F. Shillington), *Elementary Microscopy.*

The Wild Fauna and Flora of the Royal Botanic Gardens, Kew.

Cambridge Natural History. Vols. 1 and 7.

Missouri Botanic Garden, 1906.

American Botanic Gazette.

Smithsonian Report.

Proceedings of the Royal Society.

Journal of the Royal Microscopical Society.

Quarterly Journal of Microscopical Science.

Annals and Magazine of Natural History.

Proceedings of the Academy of Natural Science of Philadelphia.

Report of the British Association, 1905.

Various Proceedings of Societies and sundry pamphlets.

The journalistic work relating to the Club has been entirely in the hands of the Assistant Honorary Secretary, Mr. J. H. Pledge, during the past year, and the thanks of the members are due to him for the efficiency and regularity with which he has prepared the reports for the press. A very full précis of each ordinary meeting has again, by the courtesy of the editor of the *English Mechanic*, appeared in that paper on the fourth Friday of each month in which a meeting was held, and has proved to be of great value, not only to country members who are unable to attend the meetings, but also to microscopists in general.

The Curator reports that there has been no falling-off in the number of slides loaned during the past year, and the Committee beg to thank Mr. O. Whiting for assistance rendered in this connection. Two hundred and eighty-one slides have been added by gift and purchase, the principal donation being the preparations

of our late esteemed member, Brigade-Surgeon J. B. Scriven, consisting almost exclusively of serial sections of the blow-fly. These it has been thought better not to incorporate into the general collection of the Club, but seven separate sets have been arranged, which can be borrowed under the usual conditions. To any one interested in insect histology these preparations should prove of great usefulness, especially if used in conjunction with Dr. Lowne's classic book on the blow-fly, of which several copies are in our Library. Due acknowledgment should also be given to the kind donation of our honorary member, Dr. E. Penard, of a type collection of twenty-two slides of Rhizopoda and allied Protozoa, a group previously unrepresented in the Cabinets. The Physiological Collection has been revised and considerably augmented, and now comprises upwards of 450 preparations, exclusive of those in the Williams' Collection. The Curator proposes to make a similar revision of other sections, and, combined with additions as opportunities of purchasing occur from time to time, it is hoped that the Club will in the near future possess a collection representative of all the principal groups of natural history, although to accomplish this the Committee must of necessity rely upon the generosity of members to present slides of special interest as they may occur. Good preparations of pond life, both animal and vegetable, will at all times be welcomed.

A fine binocular microscope by Swift, with objectives and apparatus, the property of the late Mr. Edwin Larmer, whose death has already been referred to, was presented to the Club by his sister, in memory of our late member. The instrument is a notable addition to the Club's possessions, and it is intended to have the stand engraved with the particulars of the gift. It will be available for the use of members on "gossip" nights.

The excursions were well attended during the year, the total number of attendances being 173. This gives an average of over 19 at each excursion, the highest figure for some years. As usual, the excursion to the Royal Botanic Gardens was the most popular, forty-three members having passed the turnstile. The thanks of the Club are due to the boards of the Royal Botanic Gardens, the Surrey Commercial Docks, and the East London Waterworks for their courtesy in allowing the members to visit their enclosures for collecting purposes.

It is with feelings of regret that your Committee announces the retirement of the Hon. Treasurer, Mr. Henry Morland. For seven years Mr. Morland has managed the financial affairs of the Club with the most methodical care, and it is no small tribute to his ability as Treasurer that he leaves the Club in a sounder financial position than it has occupied at any previous time in its history, although the expenditure during his term of office has been largely affected by the increase in the Club's rental. On behalf of all the members the Committee beg to tender him its most sincere thanks for his long-continued and valuable services.

Mr. F. J. Perks, who since he joined the Club has taken an active interest in all its proceedings, has kindly consented to take over the treasurership, and the Committee congratulate the members on having secured the services of such an energetic successor to Mr. Morland.

The Committee also announces with regret the resignation of the Hon. Secretary, Mr. A. Earland, who finds himself unable to devote sufficient time to the heavy duties attendant on the office. He will be succeeded by Mr. W. B. Stokes, whose record as an energetic participant in the debates at meetings of the Club, and services on former committees, will ensure him the support of all the members.

In conclusion, the Committee desires to thank all the Officers for the zeal and energy with which they have conducted the affairs of the Club.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB

For the year ending December 31st, 1906.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1905	187	13	1	By Rent of Rooms and Bookcases	75	0	0
,, Subscriptions received during 1906	206	11	0	,, Expenses of Journal	67	1	7
,, Dividends on Investments	12	14	11	,, Postage	9	10	11
,, Sales of Journal	9	11	4	,, Printing and Stationery	13	5	8
,, Sales of Catalogues, etc.	3	12	3	,, Attendant	6	0	0
,, Receipts for Advertisements	19	15	0	,, Petty Expenses	5	15	0
				,, Commission *re* Advertisements	6	0	3
				,, Books, Slides, etc.	17	0	2
				,, Balance in hand	240	4	0
	£439	17	7		£439	17	7

INVESTMENTS.

	£	s.	d.
$2\frac{1}{2}$ per cent. Consols	200	0	0
$2\frac{1}{2}$ per cent. Metropolitan Consolidated Stock	100	0	0
$2\frac{1}{2}$ per cent. Annuities, 1905	100	0	0
Metropolitan Water "B" Stock	100	0	0

We have examined the above Statement of Income and Expenditure and compared the same with the Vouchers in the possession of the Treasurer, and have verified the Investments at the Bank of England, and find the same correct.

February 1*st*, 1907.

FRED HUGHES
J. MASON ALLEN } *Auditors.*
FREDK. H. HICKS

H. MORLAND, *Hon. Treasurer.*

Note.—The account for printing the Club Journal for the previous November (not having been received in time for payment before the end of the year) is not included in the above Statement as has hitherto been invariably the case. When comparing this Statement with those of previous years this account—viz. £56 11s. 2d.—should therefore be added to the above "Expenses of Journal" and deducted from the "Balance in hand."—H. Morland.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB

For the year ending December 31st, 1906.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1905	187	13	1	By Rent of Rooms and Bookcases	75	0	0
„ Subscriptions received during 1906	206	11	0	„ Expenses of Journal	67	1	7
„ Dividends on Investments	12	14	11	„ Postage	9	10	11
„ Sales of Journal	9	11	4	„ Printing and Stationery	13	5	8
„ Sales of Catalogues, etc.	3	12	3	„ Attendant	6	0	0
„ Receipts for Advertisements	19	15	0	„ Petty Expenses	5	15	0
				„ Commission *re* Advertisements	6	0	3
				„ Books, Slides, etc.	17	0	2
				„ Balance in hand	240	4	0
	£439	17	7		£439	17	7

INVESTMENTS.

	£	s.	d.
$2\frac{1}{2}$ per cent. Consols	200	0	0
$2\frac{1}{2}$ per cent. Metropolitan Consolidated Stock	100	0	0
$2\frac{1}{2}$ per cent. Annuities, 1905	100	0	0
Metropolitan Water "B" Stock	100	0	0

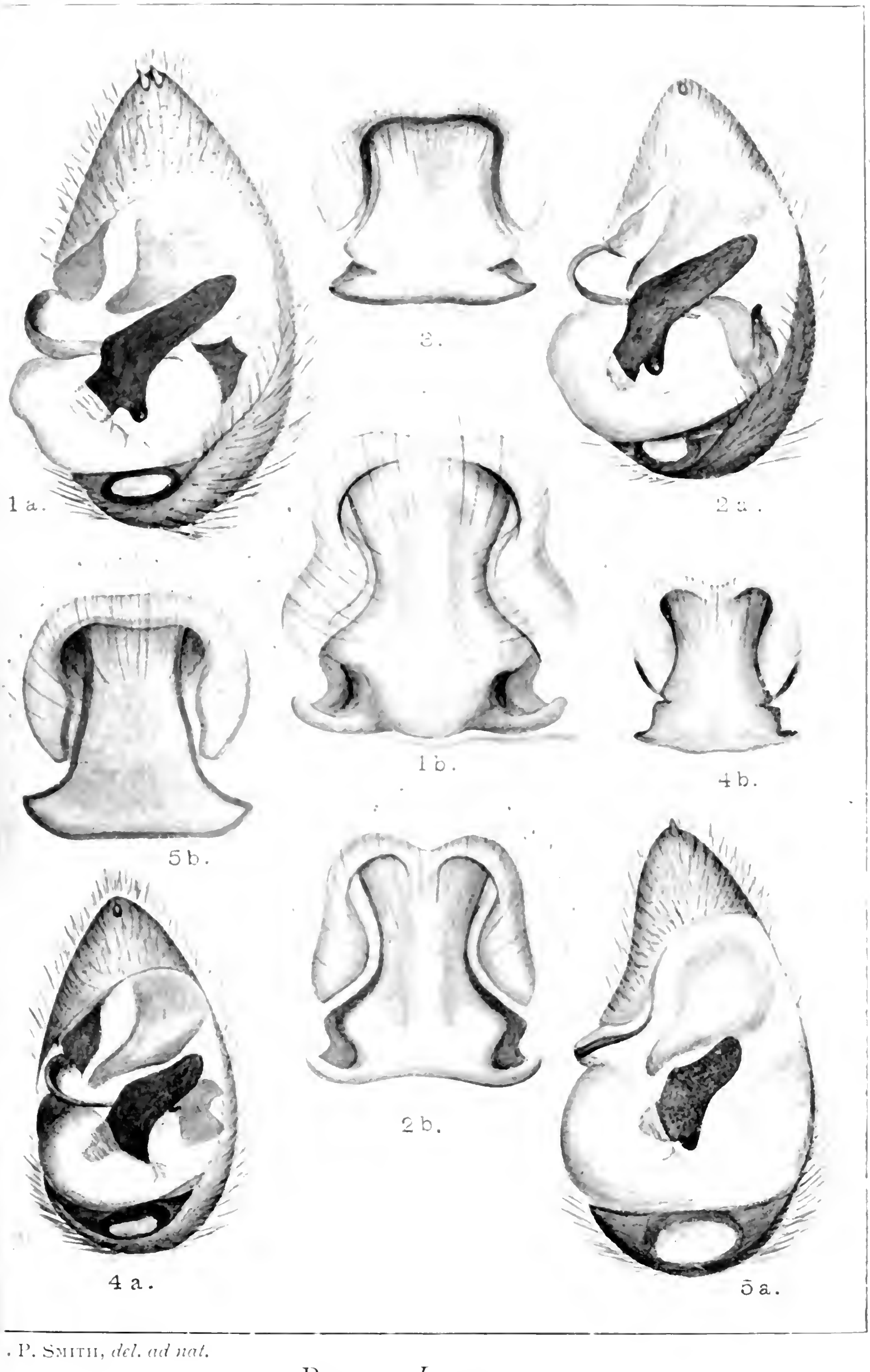
We have examined the above Statement of Income and Expenditure and compared the same with the Vouchers in the possession of the Treasurer, and have verified the Investments at the Bank of England, and find the same correct.

February 1st, 1907.

FRED HUGHES
J. MASON ALLEN } *Auditors.*
FREDK. H. HICKS

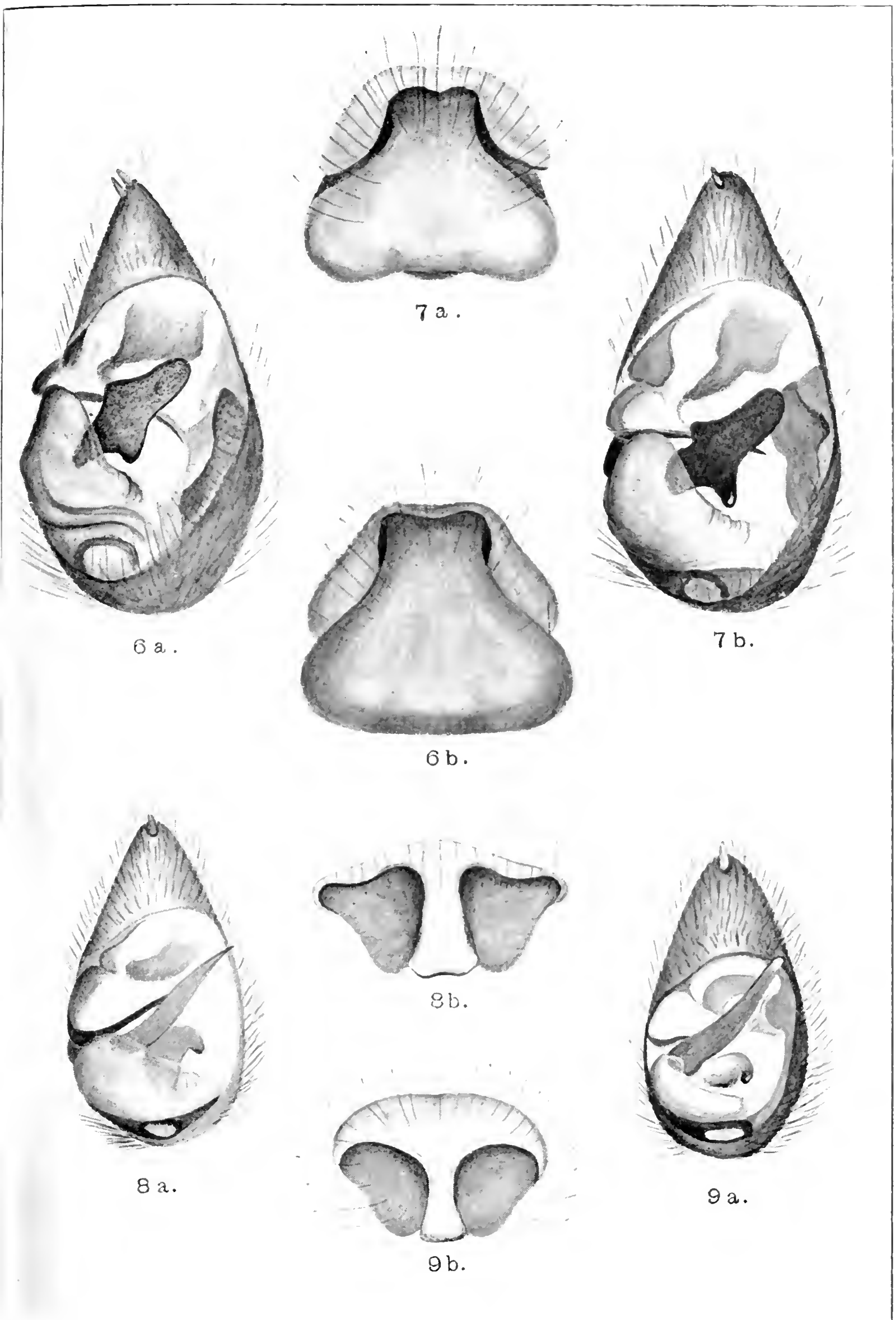
H. MORLAND, *Hon. Treasurer.*

Note.—The account for printing the Club Journal for the previous November (not having been received in time for payment before the end of the year) is not included in the above Statement as has hitherto been invariably the case. When comparing this Statement with those of previous years this account—viz. £56 11s. 2d.—should therefore be added to the above "Expenses of Journal" and deducted from the "Balance in hand."—H. MORLAND.



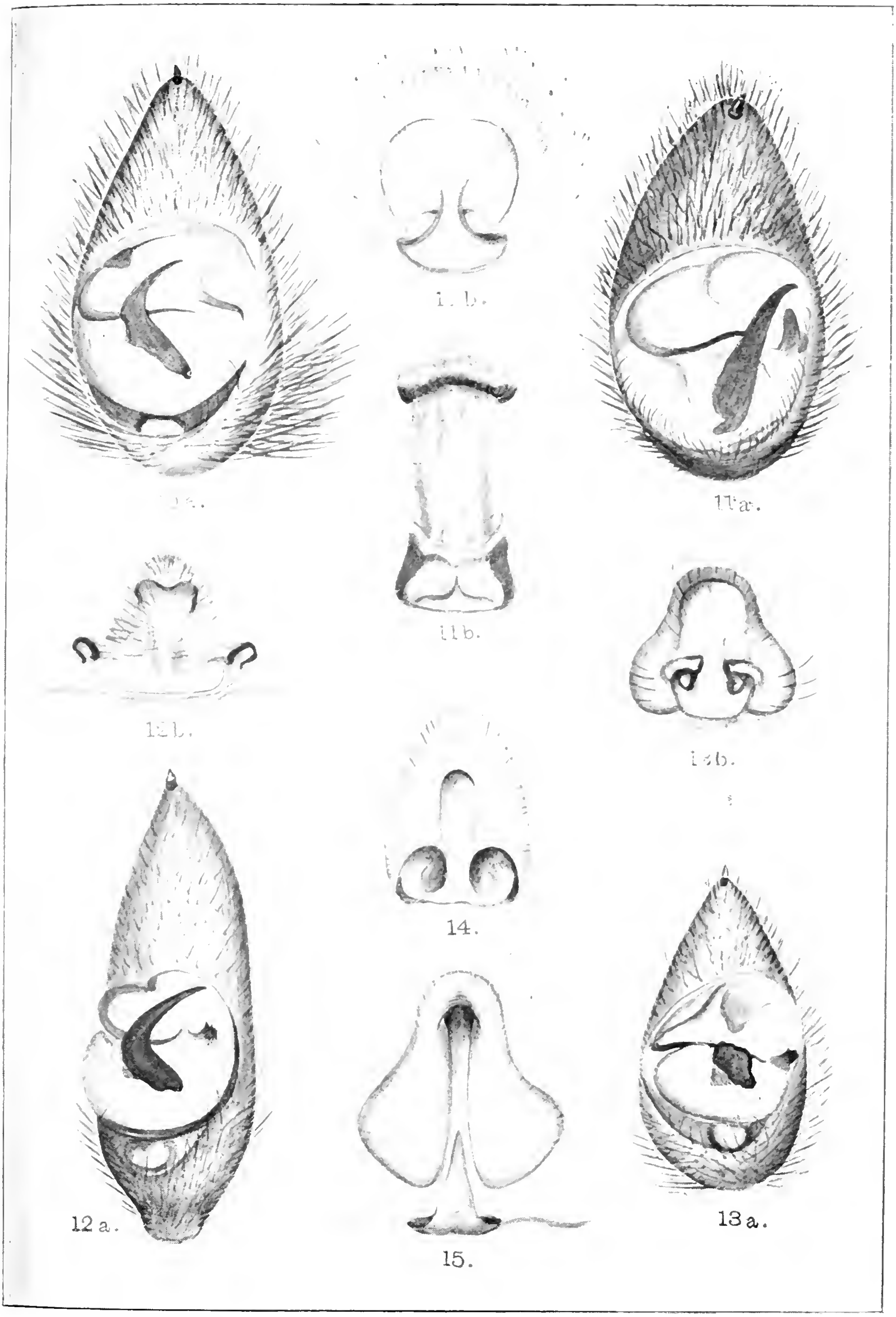
. P. Smith, *del. ad nat.*

BRITISH *LYCOSAE.*



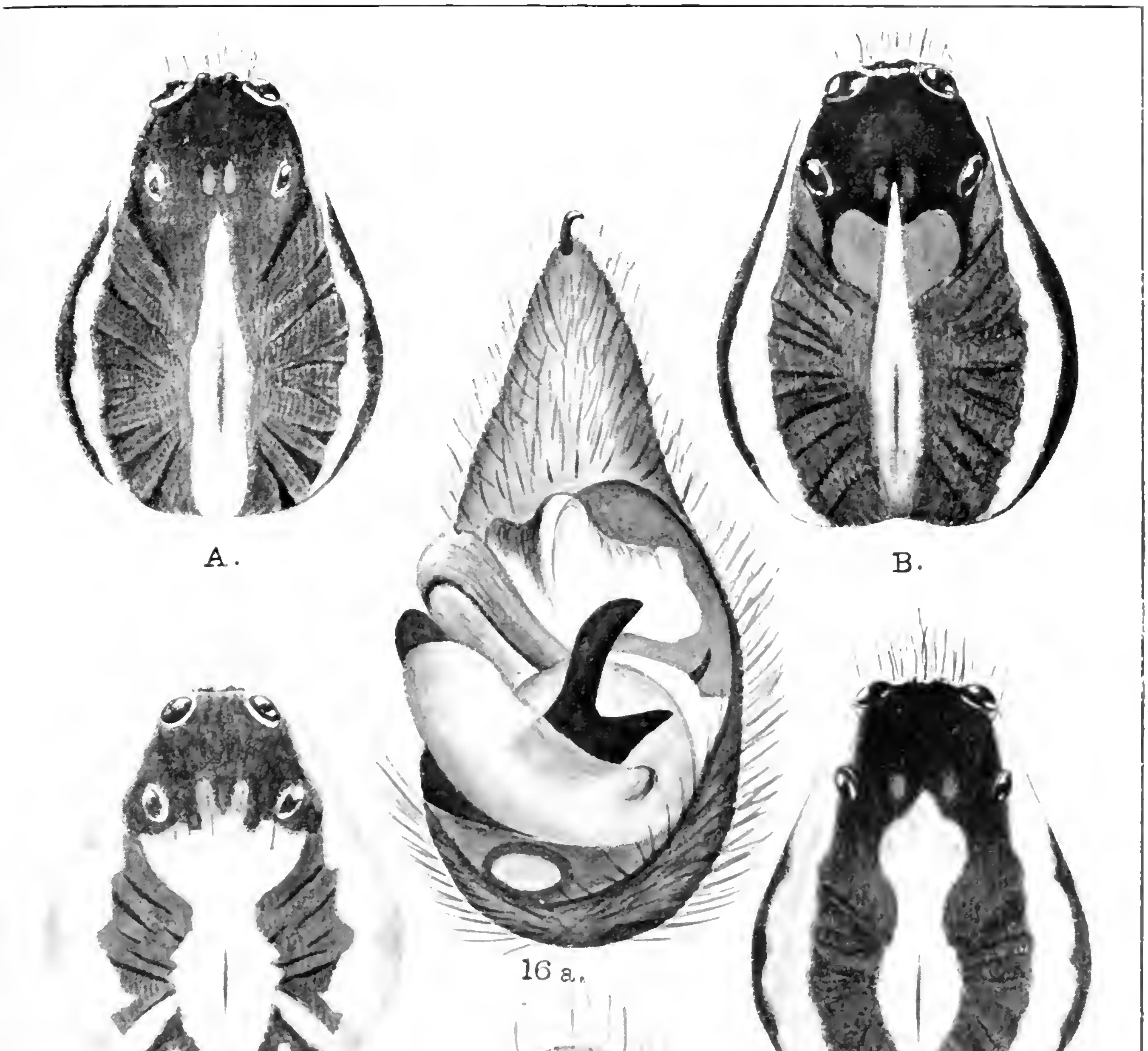
F. P. Smith, *del. ad nat.*

British *Lycosae.*



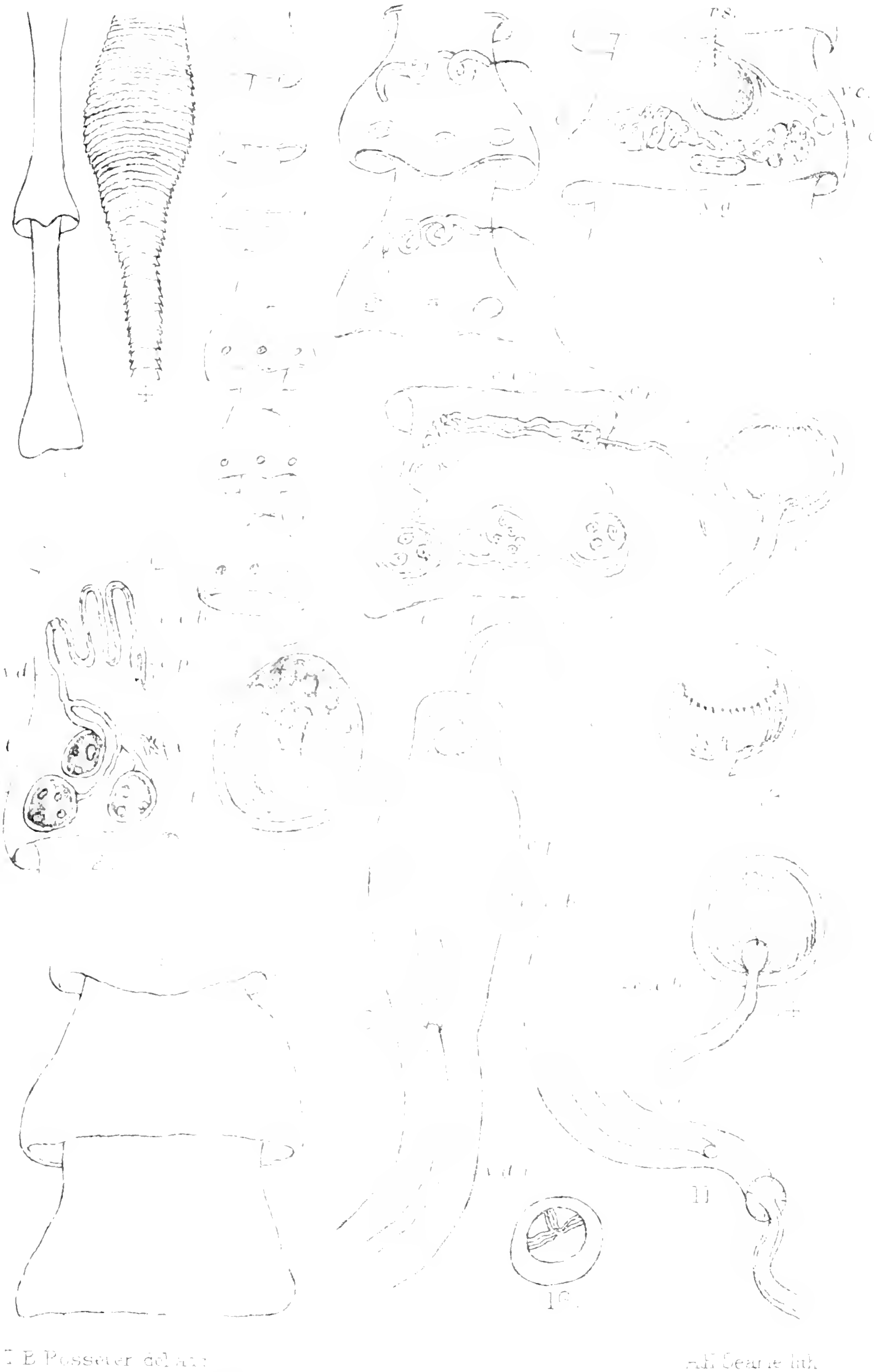
F. P. Smith, *del. ad nat.*

British *Lycosae.*



F. P. Smith, *del. ad nat.*

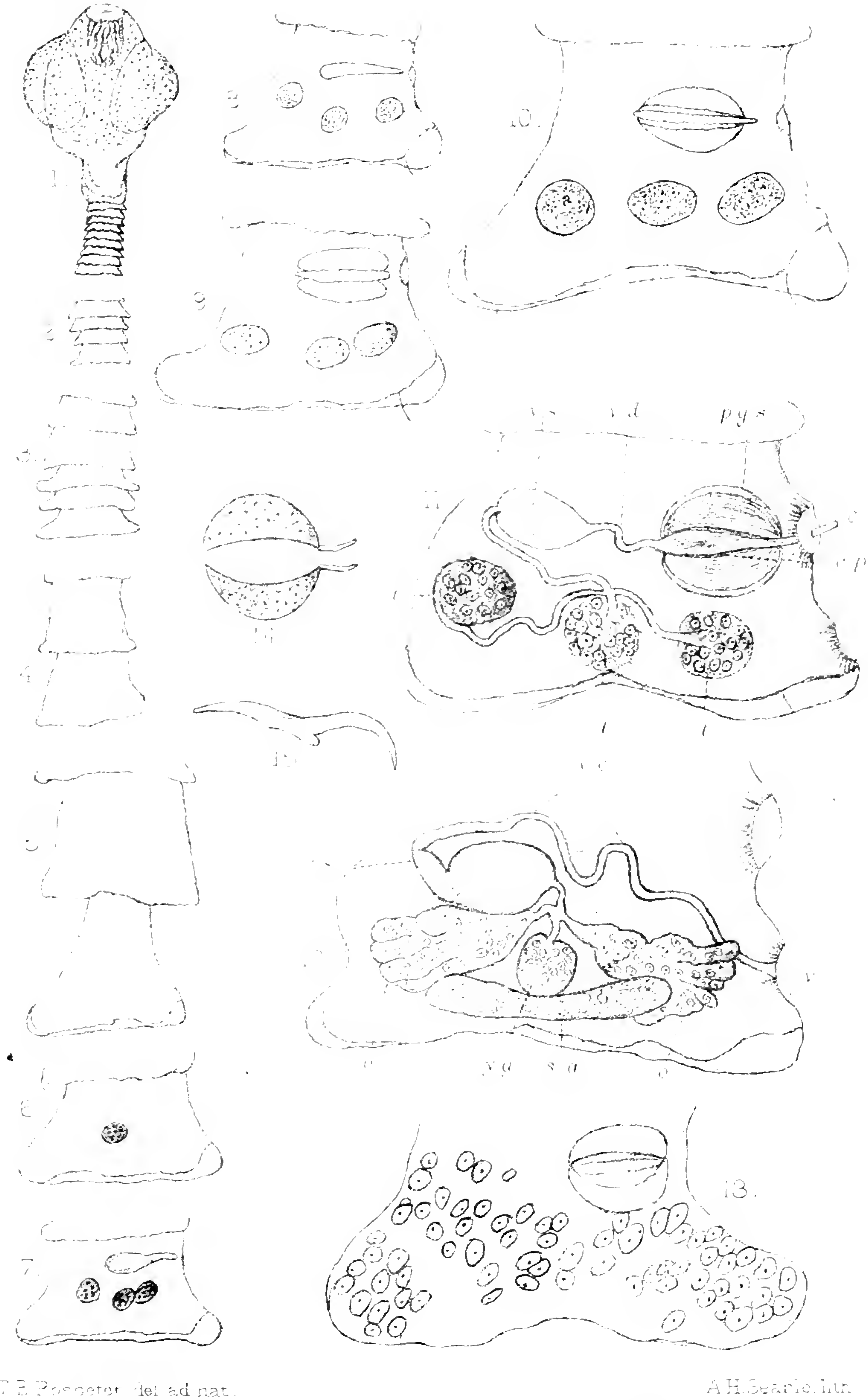
British *Lycosae*.



T. B. Rosseter del. ad nat.

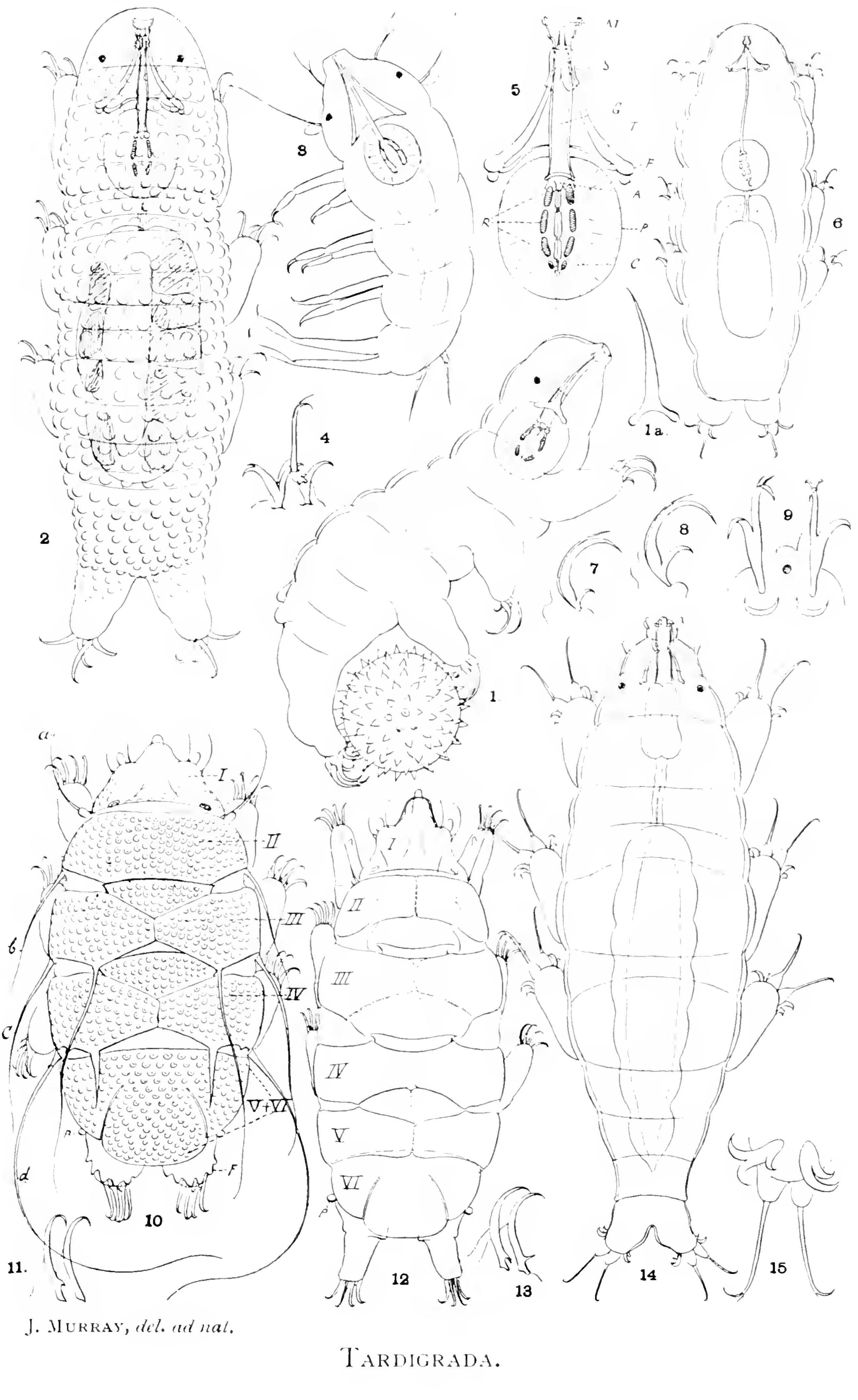
A. H. Searle lith.

Hymenolepis nitida Krabbe.



T. B. Rosseter del. ad nat. A. H. Searle, lith.

Hymenolepis nitidulans. *Krabbe.*



J. Murray, *del. ad nat.*

Tardigrada.

D. J. Scourfield del.

A. H. Searle lith.

1–4, Alona weltneri. *Keilhack.*
5–10 Pleuroxus denticulatus *Birge.*

ON THE COLLECTION AND PRESERVATION OF FRESH-WATER RHIZOPODS.

By Dr. Eugène Penard (Geneva).

(*Read April 19th*, 1907.)

Amongst the lower organisms which are found in fresh waters there are few the study of which is so attractive as that of the Rhizopoda. A special interest indeed attaches to these little creatures owing to the fact that, as much from the systematic point of view as on account of their finer structure, their development, their physiology, even their ways and habits, there still remains much to be discovered about them.

Nevertheless, the systematic study of fresh-water rhizopods is still too much neglected, probably because, by reason of their minute size, special difficulties are dreaded. However, these difficulties do not exist, or at any rate are not greater than those met with in any other group; in some respects even it may be said that the study of rhizopods is comparatively easy, and as regards the methods of obtaining specimens the difficulties are not worth mentioning.

After a fairly long experience in the manipulation of these Protista I may hope perhaps to be able to offer some advice to those who seek to understand them, and I may be allowed to devote a few pages to the collection, examination, and preservation of fresh-water rhizopods.

Collecting.

Collecting is as simple as possible, but here a distinction must be made between ponds, streams, and marshes on the one hand and those deep lakes, which require apparatus a little more complicated, on the other.

In the first case this is my procedure: Holding in my right hand a test-tube 12 cm. ($4\frac{3}{4}$ in.) long and 2 cm. ($\frac{4}{5}$ in.) in diameter, I close its mouth with my thumb and plunge my whole arm in the water, so as to bring the test-tube to the level of the mud, just to touch that sort of organic felt which usually covers the bottom. Then, raising the thumb, I free

the mouth of the test-tube, the water rushes in, carrying with it the surface-mud, which is always the richest in organisms of all kinds. Then I empty the contents of the test-tube into a larger receptacle—a wide-mouth bottle perhaps, or a long tin canister which I carry with me. After this I begin to fish again, plunging my tube sometimes here, sometimes there, especially in those places where the yellow, brown, or greenish felt of the bottom is thickest, each time emptying the contents of the test-tube into the receptacle.

When the latter is full, I allow the sediment to settle for two or three minutes, and then I decant, pouring off the clear part of the liquid and returning the deposit into the same test-tube which I have just been using. The latter, well corked and wrapped in a piece of damp linen, goes into my pocket, and the gathering is made; it only remains to find another pool and to fill a second test-tube.

On returning home I empty my test-tube into a jar full of clean water; but I usually take the precaution of passing the collection through a wire gauze sieve with a $\frac{1}{2}$-mm. mesh. The largest rhizopods easily pass through the mesh,* and the coarse deposit (algae, small molluscs, vegetable threads, etc.), which hinder examination considerably, remain on the sieve.

When the bottom of the marsh is covered by a close carpet of aquatic mosses, collecting is simpler still. It is quite enough to take a handful of mosses, green and free from mud if possible, and wrap it up in wet linen. It will then only be necessary to shake the mosses in a pot filled with water, and to turn the contents of this pot into a jar previously covered with a wire sieve.

The aquatic mosses, when they form a thick carpet, are often very rich in organisms of all kinds, and rhizopods show themselves in quantities. Richer still are the tufts of sphagnum, where these animals are always extraordinarily numerous, represented most often by particular species, mainly of the large family of the Nebelidae.

If now we suppose that we have to do with a large lake, and we wish to take a gathering at a depth of 10, 20, 40 metres, or

* With two or three exceptions, more particularly among the species from the great depths of lakes, where, moreover, owing to the fineness of the mud particles, sifting is useless.

more, the operations, although still very simple, require a special apparatus. The following is my method when far out in a small boat on the Lake of Geneva.

At the end of a long fishing-line I attach a long, rectangular tin receptacle 14 cm. ($5\frac{1}{2}$ in.) long and 6 to 7 cm. ($2\frac{1}{2}$ to $2\frac{3}{4}$ in.) wide, fastened to the line by a metal loop (not by hempen cords, which easily twist round one another). In front and about a metre from the receptacle is a weight, a lump of lead weighing about 500 grm. (1 lb.).

I allow the whole to drop to the bottom, then I begin to row very slowly—at the rate of hardly half a metre per second (about one mile an hour)—so that the lump of lead drags on the bottom, and does not leave it.

After a minute I slowly withdraw my apparatus, and I generally find it more or less full of mud, mixed with large strips of brown organic felt, which have been torn from the upper surface of the mud, and almost alone contain the rhizopods.

On returning home I turn the whole into a large jar, and allow it to stand; the water clears very slowly, and after two or three days there is formed on the surface of the mud a fine felted coating of a lovely golden brown, formed for the most part of beautiful deep-water diatoms, but in which rhizopods are also fairly plentiful.*

This system of collecting, as one can see, is again pretty simple: even too simple perhaps some will say, for in being raised from the bottom to the surface of the lake the receptacle may lose a good part of its contents. But in reality it loses little, and the material which remains at the bottom of the receptacle is often more abundant than is desirable, for too large a gathering is sometimes troublesome.†

* In order to obtain large species like *Difflugia lebes*, *D. pyriformis*, etc., one may employ this equally useful method. Put the collection into a fairly tall cylindrical jar and decant several times, first every minute and then more rapidly. After about thirty decantations all the fine mud has gone, and there remains an extremely rich residue, in which may be found a good number of large rhizopods, crustaceans, small worms, etc.

† For very special gatherings, where it is intended to make a clear distinction between the organisms of the bottom and those which are pelagic, the system of a constantly open receptacle is certainly defective (less, however, than one would think, for in rising to the surface a receptacle with a water-tight bottom drives back the water before it,

Examination.

It is not my intention to deal here with a thorough examination of rhizopods, but there is one detail to which I believe it useful to draw attention.

It often happens that a certain animal, found under the cover-glass in the midst of organisms and débris of all kinds, does not lend itself to observation without difficulty: it is half hidden by the detritus, or will soon be hidden altogether. Now, it is essential for a good observation (as, for instance, to examine the nucleus or to make it come out of the animal) that the specimen be isolated and examined in a drop of clean water. I do this in the following way:

Suppose that the organism, for example a small *Difflugia*, is under the cover at the place marked by the little cross shown in Fig. 1. I note the exact position: I see, for instance, that a little below and to the left of the *Difflugia* is an easily visible object, let us say a large diatom.

I carefully transfer the slide to the dissecting microscope (*la loupe montée*), where I easily find the diatom again, which, this time, as the object is no longer inverted to the observer's eye, should appear to the right and above the *Difflugia*, and, thanks to this point of reference, I am able to discover the latter (Fig. 2).

At this moment, without losing sight of the *Difflugia* for an instant, I add to the right edge of the cover a large drop of water (Fig. 2), and then with a needle I get rid of the cover by sliding it to the right (Fig. 3).*

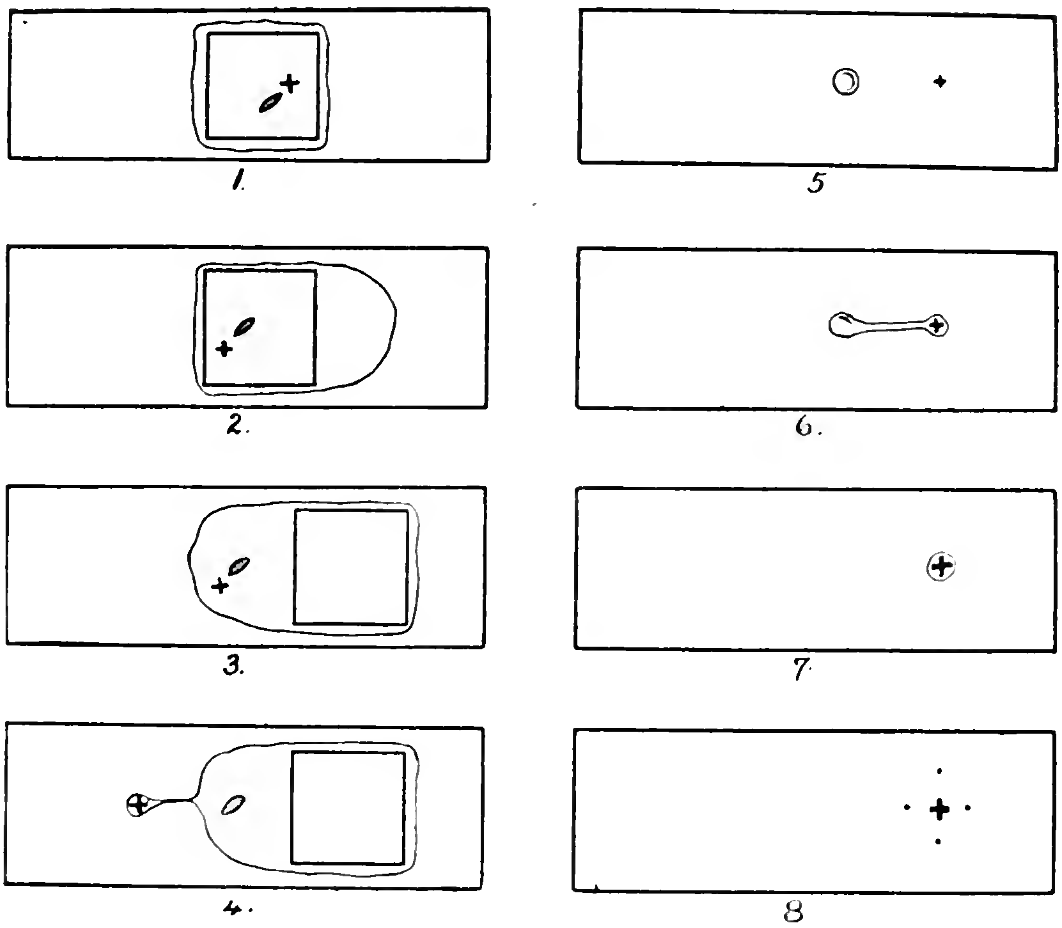
The little *Difflugia* is still there, but this time in open water. With the same needle I push it to the left, always enclosed

and collects almost nothing); but as regards rhizopods, there is no cause for anxiety, for these organisms live exclusively on the bottom: in large lakes one never finds them in the open water, except the curious *Difflugia hydrostatica*, which is sometimes pelagic, and sometimes, perhaps, *Cyphoderia ampulla*. For the rest, even with a marsh, one must never forget that only the bottom will be generally productive, except where the bottom is clothed with aquatic plants, which rise to the surface, carrying with them the organisms which are borne on their stalks.

* The addition of this drop of water is only to allow the cover to slide easily by floating on the liquid. Without this precaution it would disarrange everything when moved, and the *Difflugia* would run the risk of being lost.

in a little water, then, when it is well isolated (Fig. 4) I raise the cover, and with a rag I clean the slip to the right of my rhizopod. It only remains to let fall a drop of clean water on to the slip, introduce the rhizopod into it by means of the needle, and cover all again with a fresh cover-glass.

All these operations, which may appear intricate, are not so really, and only require two or three minutes as a rule, often even less. The animal is then well isolated, and easily examined, and, without any fear of losing it, it is possible



to compress it, so as to drive out the nucleus, detach the scales or break up the plasm, or to keep it living for many hours, and even, by taking care to add water to one of the edges of the cover from time to time, and covering the slide with a large capsule and a wet cloth, to keep the animal for several days, almost indefinitely.

It is often important also to make sure of the nature of the shell, to destroy the chitinous part, to isolate the siliceous scales of *Euglypha*, *Nebela*, etc., or the needles of Heliozoa, and to do that, I have often found it advantageous to subject the shell either to the action of boiling sulphuric acid, or to the flame of the blowpipe.

Suppose that in Fig. 5 the little cross to the right indicates the rhizopod. A little to its left I let fall from a pipette a very small drop of concentrated sulphuric acid; then with a point I draw a little of the acid from the droplet up to the rhizopod, which I finally drown in this reagent (Fig. 6). With an old rag I dry up the drop of useless acid, and now I have my rhizopod isolated, this time no longer in water as was the case in Fig. 4, but in a minute drop of sulphuric acid (Fig. 7).* Then taking the slide either in the fingers or with the forceps by the end farthest from the droplet, and holding it flat, I pass it carefully over the flame of a spirit-lamp until the acid fumes away, and finally everything is dry. At this moment the siliceous parts of the shell are separated; not always sufficiently, however, and often all is black, carbonised, and it is necessary to have recourse to the blow-pipe.

With ordinary ink I mark on the slip four black dots, so placed that the shell is at the intersection of two imaginary lines which join the points in a kind of cross (Fig. 8); then taking the slip with the forceps, I pass it *with great care* over the flame, and lastly, when it is thoroughly hot, almost red, I direct the flame of the blow-pipe from underneath, obliquely upwards, first gently and then more fiercely, on the part where the black dots are seen. The carbonaceous parts burn immediately, the glass begins to puff up, and I place the slip on a non-conducting object—a match-box, for instance—to wait awhile, and then to find under the microscope a little group of very clear scales.

It often happens, it must be admitted, that the glass slip breaks during the operation; but with care it is successful three times out of four, and even in unsuccessful cases on picking up the broken fragments the desired siliceous elements are often found more or less incrusted on the glass, which had begun to melt.

Microscopic Preparation.

Many naturalists are led to believe that the preparation of rhizopods for microscopic collections is something particularly difficult. It is not so, however, and it may even be said that

* Very little acid must be left round the rhizopod. If there is too much, the separated scales will be dispersed in every direction during the boiling of the acid, and will not be found.

these organisms—at any rate, those which are furnished with a shell—lend themselves more readily than many others (as, for instance, infusorians or rotifers) to the formation of a collection of types where the specific characters will be clearly distinguished.

I should like, therefore, to describe the means I employ. My methods vary according to the case, and I can give three.

First Method.

It often happens that there is seen in the midst of algae and various débris which fill the field of the microscope a particular organism, either abnormal, belonging to a rare species, or in course of division, etc., which it is wished to fix at once. In this case I isolate it in the manner shown above, and when it is enclosed in a droplet of pure water on the clean slip, I flood it with a jet of absolute alcohol from a pipette.*

After a minute or two, during which it is necessary to watch the specimen, which must not be dry *for an instant*, I add a drop of borax-carmine, then a moment later I add water; with a needle I push the rhizopod sideways on to a part of the slip which has just been wiped, and I introduce it into a drop of pure water that I have placed there. I clean all the slip (naturally leaving alone the droplet containing the rhizopod), again I flood the drop with absolute alcohol, and again I clean a part of the slip, and on this dry part let fall a drop of oil of cloves; with a needle I trail a little of the oil like a sort of canal or bridge up to the rhizopod, and lastly I reverse the movement, pushing the rhizopod itself the length of this bridge up to the drop of oil. The slip is cleaned once more, and I push the rhizopod to the centre, leaving round it very little of the oil. I clean again, let fall on the specimen a drop of Canada balsam, cover with a round cover-glass, and the preparation is finished.

All this manipulation, which would appear to be long and intricate, has really only lasted ten minutes, often less, but sometimes more in difficult cases. It requires a little skill and sustained attention, but offers no special difficulties.

* Here, as in the two other methods about to be described, this sudden drenching with absolute alcohol is to kill the organism before it has had time to withdraw its pseudopodia. This way is undoubtedly rather primitive, and I have no doubt that a naturalist more used to reagents than I am will be able to get better results; but it succeeds often enough, and recommends itself by its simplicity.

Second Method.

Suppose that in a gathering I have noticed an abundance of a certain species—say *Difflugia pyriformis*—which I wish to mount in great numbers.

After having put some parcels of the gathering in a large flat-bottomed capsule (such as a cover of one of those glass boxes that are supplied by all dealers in microscopical apparatus), I take the animals in a pipette one after the other under the simple microscope, and I transfer them, with such impurities as may accompany them, into another flat-bottomed capsule filled with clean water. After a moment I take these specimens again under the simple microscope, and transfer them to a watch-glass, where this time the impurities are in a negligible quantity.*

From this watch-glass I remove the greater part of the liquid, only leaving my *Difflugiae* with just sufficient water to enable them to spread out their pseudopodia freely. I allow the glass to rest for about a quarter of an hour, and then suddenly, from a well-filled pipette, I drench all with a jet of absolute alcohol, taking care that the stream of alcohol is abundant, and makes a circle round the liquid which covers the bottom of the watch-glass, for without this precaution the specimens are often thrown to the side on to the dry glass, where the plasma shrivels up immediately.

After some minutes I withdraw a part of the alcohol and replace it with borax carmine, which I allow to act for some time—for a quarter of an hour to an hour, according to the strength of the reagent.†

* To avoid the risk of losing individual specimens during these transfers, it is necessary to fill the pipette gently and only half full. If it is allowed to fill rapidly and right up, it generally produces a whirl which draws the object to the surface of the water that is sucked up. The object immediately gains the edge of the concave surface of the water, and fixes itself to the glass, from which it is removed with difficulty.

† The strength of the carmine depends on the way in which it has been prepared. Certain rhizopods, however, colour more quickly than others; and in all, if it is wished to colour the pseudopodia sufficiently, the nucleus must be sacrificed more or less, as it will be too deeply coloured, only showing a large spot of dark red, the nucleoli not being distinguishable from the rest of the nuclear mass.

After this I eliminate the carmine by withdrawing portions of the rose-coloured liquid with the pipette several times, replacing them with clear water.

In its turn I replace the clear water by alcohol in the same manner, until at last the specimens are in almost absolute alcohol. At this moment I withdraw nearly all the alcohol (taking care, however, that the *Difflugiae* are not dry for a single instant) and I replace it by oil of cloves.

When it is all clear I take in the pipette half a dozen *Difflugiae*; I let the drop fall near one end of the slip, and from this drop, under a lens, I push the *Difflugiae* towards the centre of the slip, where I reunite them in a little group. I wipe the slip, and it only remains to cover the *Difflugiae* with a drop of Canada balsam.*

Third Method.

This method is excellent when, for instance, one wishes to profit by a rich gathering to make a great number of slides at a time.

In this case I put a small part of the gathering (as far as possible the upper layer of the detritus that was deposited in the jar) into a large test-tube 19 cm. high by 4 cm. wide ($7\frac{1}{2}$ in. by $1\frac{1}{2}$ in.) with a flat bottom; then, when it is quite settled, I carefully decant the liquid, leaving only a very thin layer of water above the deposit.

After half an hour, when I judge that the animals have spread out their pseudopodia freely, I suddenly turn in to the test-tube a

* Perhaps the Canada balsam ought to be replaced by some other substance. If it does possess the great advantage of preserving the object indefinitely, it has the inconvenience of drying too slowly, and often after whole years objects in it are displaced. To meet this disadvantage I now use a very thick balsam, almost hard. Putting the bottle which holds the balsam on a thick iron plate, I heat on a *very gentle* fire until the balsam becomes very liquid; then I transfer everything—hot plate and bottle—on to the work-table, where also, quite ready with the specimens centred, are the slides to be covered. The bottle will keep the balsam sufficiently liquid for an hour, at 40° to 50° centigrade, which temperature does not distort the specimens. By this means is gained perhaps a year, or even two, on the time required before the specimens are immovable in the balsam.

large quantity of absolute alcohol so as to kill the organisms instantaneously with their pseudopodia extended.*

The material settles again very quickly, and I get rid of the greater part of the alcohol, which I replace by a small quantity of borax carmine; then after a moment I refill the test-tube to the brim with clean water, I allow it to stand, decant and refill again with clean water and repeat in the same way until, after half a dozen decantations, the deposit is found to be in perfectly pure and uncoloured water.

I then throw away most of the water and transfer the material to a test-tube much smaller and more convenient, requiring a smaller expenditure of alcohol, and oil. I decant several times with absolute alcohol, then finally replace the alcohol with oil of cloves; and I have then a collection of rhizopods which only requires sorting, either in a watch-glass or on a slip, and enclosing in balsam according to the method already described.

The organisms may be preserved for weeks and months in the oil of cloves, and during the summer it is possible to form a series of tubes with the different gatherings and reserve them for mounting as microscopic slides in the winter.

* This method is still rather defective, as most individuals have time to withdraw their pseudopodia into the shell; but, as a rule, it succeeds with a certain number of them, and sometimes this denotes a character which might be called specific, some species behaving differently from others. Thus *Difflugia scalpellum*, that pretty species from the bottom of Lake Geneva, is obtained with its pseudopodia extended easily enough, while others (notably all species with filiform pseudopodia which probably break off) show them very rarely. It is a curious thing that, in these gatherings treated in bulk, Infusoria (those creatures always so difficult to prepare) are often met with and in a fairly good condition. It was thus that I happened to find specimens of *Lionotus* which lent themselves perfectly to preservation in balsam and showed their long necks well thrown out, which an authority tells me he has never been able to obtain in a good state in spite of the most refined reagents.

RECENT FORAMINIFERA OF VICTORIA: SOME LITTORAL GATHERINGS.

By Fredk. Chapman, A.L.S., F.R.M.S.

(*Read May 17th*, 1907.)

Plates 9 and 10.

The shells of Foraminifera are found abundantly on the shores both of Port Phillip and the Victorian coast generally; but, notwithstanding this, they appear to have been up to the present so overlooked that the chief recorded list is that given by Professors Parker and Jones as early as 1865.* That list comprised thirty-two species, and the specimens were obtained from a sample of "coast-sand, Melbourne, Australia," which consisted of "coarse quartz sand, full of shells, zoophytes, sponges, and algae."

A paper on the "Foraminifera of Victoria," by H. Watts, published in 1883,† besides furnishing some short lists of fossil forms, gives one of recent Foraminifera from tide-pools at Beaumaris, Griffith's Point, Queenscliff, etc., comprising six species, all of which are herein recorded if we read *Biloculina* "*compressa*" as *B. depressa*, and *Spiroloculina* "*canaliculata*" as *S. nitida*.

A short note on the "Foraminifera of Shoreham, Western Port," was published by myself in 1902,‡ when seventeen species were enumerated, only one being common to Parker and Jones' list. Since then I have added a few more species for this locality, herein recorded. The Foraminifera of the Port Adelaide area have been very thoroughly worked over by the Rev. W. Howchin, F.G.S.,§ and his list will help to form a basis of comparison with our own fauna.

Besides collecting material myself from various localities,

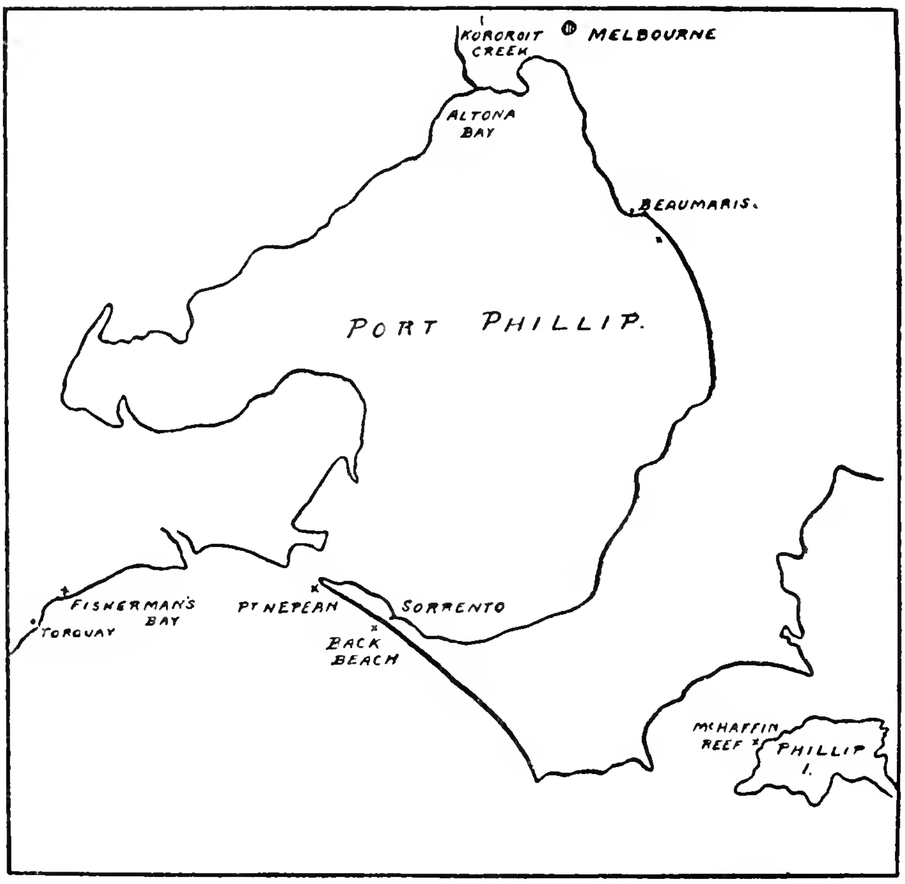
* *Phil. Trans.*, vol. 155, pt. i., p. 438.

† *Southern Science Record*, vol. iii., No. 3, p. 77.

‡ *Victorian Naturalist*, p. 112.

§ "The Estuarine Foraminifera of the Port Adelaide River." *Trans. R. Soc. S. A.*, vol. xiii., 1890, pp. 161—169.

Messrs. T. S. Hall, M.A., and E. O. Thiele have kindly gathered material for this paper. Mr. Hall's sample of shore-sand from Beaumaris was obtained under exceptionally favourable conditions, for it yielded a large number of the species only now recorded from Victoria, besides many interesting Ostracoda which will be described at the first opportunity. The shore-sand from McHaffie's Reef, also obtained by Mr. Hall, is noteworthy on account of certain rare forms which it contains, such as *Cassidulina parkeriana* and *Lagena fasciata*.



This contribution to a description of the recent Victorian Foraminifera has no pretension to be exhaustive; but since it is necessary to obtain some idea of the distribution of the commoner species, in order to form a comparison with those occurring in our Tertiary strata, it has been thought advisable to publish the following results as a preliminary inquiry into this section of the Victorian marine fauna. These notes deal with 103 species and varieties, one species and three varieties being apparently new.

The localities which have afforded us material up to the present are Altona Bay (denoted A.B. in the systematic description); Beaumaris (B.); Shoreham, Western Port (Sh.); McHaffie's Reef,

Phillip Island (M.H.); and Torquay, Jan Juc (T.). A few selected Foraminifera have been kindly given me by Mr. J. H. Gatliff, from Point Nepean (P.N.) and Sorrento (S.), which are also included here. It should be noted that the foreshore of Beaumaris is backed by Tertiary cliffs of a more or less sandy and fossiliferous nature; and in examining the tidal floatings from this locality it is well to bear in mind the possibility of finding a few fossil Foraminifera included in the shore-sand. Fossils thus derived are distinguished by their stained appearance and infilled chambers, and such have been discarded from our lists. The gatherings from Torquay were obtained from Fisherman's Bay. At this locality the foreshore is bounded by calcareous sand-dunes, so that the risk of meeting with derived fossils here is reduced to a minimum. Further to the west, in the neighbourhood of Spring Creek, I have repeatedly failed to find Foraminifera, although shells of young molluscs are abundant at times. Altona Bay has a foreshore of calcareous and quartzose sand, with a low fringing raised beach full of marine shells; but since the Pleistocene Foraminifera from the old beach would be scarcely different from the present fauna, the chances of an occasional specimen washed down need not be seriously considered. The two remaining localities, Shoreham and McHaffie's Reef, on opposite sides of Western Port, have the foreshore skirted by basaltic rocks, so that here there is no possibility of the inclusion of derived forms.

ORDER **FORAMINIFERA.**

FAMILY MILIOLIDAE.

SUB-FAMILY NUBECULARIINAE.

Genus **Nubecularia,** Defrance.

Nubecularia bradyi, Millett.

N. inflata, Brady (non Terquem), 1884, *Rep. Chall.*, vol. ix., p. 135, pl. i., figs. 5—8.

N. bradyi, Millett, 1898, *Journ. R. Micr. Soc.*, p. 261, pl. v., figs. 6, *a*, *b*.

This species, although Nubecularian in its general characters, may probably be related to *Miliolina labiosa*, as Brady has already

pointed out, and of which relationship there is further evidence in its apertural character and close association in the littoral sands near Melbourne. It has already been recorded from several localities in the Pacific, generally in the shore-sands of coral islands, and Millet records it from the Malay Archipelago.

T., very common; M.H., rare.

Sub-family Miliolininae.

Genus **Biloculina**, d'Orbigny.

Biloculina depressa, d'Orbigny.

B. depressa, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 298, No. 7.

Sh., very rare and rather small.

Genus **Spiroloculina**, d'Orbigny.

Spiroloculina nitida, d'Orbigny.

(Pl. 9, Fig. 1.)

S. nitida, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 298, No. 4; Brady, 1884, *Rep. Chall.*, vol. ix., p. 149, pl. ix., figs. 9, 10.

This species is common in shallow water of tropical and warm-temperate areas. The Victorian examples vary in the direction of a square periphery as in *S. planulata*, Lam. sp.; otherwise they are typical.

M.H., very rare; Sh., very rare.

Spiroloculina grata, Terquem—and varieties.

S. grata, Terquem, 1878, *Mém. Soc. géol. France*, sér. 3, vol. i., p. 55, pl. x., figs. 14, 15.

The Victorian specimens, by their rounded peripheral edge and fine, regular striations, link themselves to *S. antillarum*, d'Orb.

A.B., frequent; B., frequent, well-grown examples.

Genus **Miliolina**, Williamson.

Miliolina oblonga, Montagu sp.

Vermiculum oblongum, Montagu, 1803, *Test. Brit.*, p. 522, pl. xiv., fig. 9.

Miliolina oblonga, Mont. sp.; Millett, 1898, *Journ. R. Micr. Soc.*, p. 267, pl. v., figs. 14, *a*, *b*.

A.B., common; B., very common; M.H., very rare; T., frequent.

Miliolina bosciana, d'Orbigny sp.

Quinqueloculina bosciana, d'Orbigny, 1839, *De la Sagra, Hist. Phys. de l'Ile de Cuba, Foram.*, p. 191, pl. xi., figs. 22—24.
Miliolina bosciana, d'Orb. sp.; Millett, 1898, *Journ. R. Micr. Soc.*, p. 267, pl. vi., fig. 1.

This species differs from the preceding in having more oblique sutures. Our Victorian specimens do not show the alveolate, striate, or agglutinate surfaces described by Millett from Malayan specimens, but generally have a smooth shell. The striate variety is occasionally met with at Altona Bay.

A.B., common; B., very common; M.H., very rare.

Miliolina rotunda, d'Orbigny sp.

Triloculina rotunda, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., No. 4, p. 299.
Miliolina rotunda, d'Orb. sp.; Millett, 1898, *Journ. R. Micr. Soc.*, p. 267, pl. v., figs. 15, 16.

A.B., very rare; Sh., very rare.

Miliolina circularis, Bornemann sp.

Triloculina circularis, Borneman, 1855, *Zeitschr. d. deutsch. geol. Gesellsch.*, vol. vii., p. 349, pl. xix., fig. 4.
Miliolina circularis, Born. sp.; Egger, 1893, *Abhandl. bayer. Akad. Wiss.*, Cl. II., vol. xviii., abth. ii., p. 235, pl. ii., figs. 61—63.

The Victorian examples agree on the whole with the Biloculine and Triloculine varieties ascribed to the type of *M. circularis*. One or two specimens, however, show the Quinqueloculine modification which links the form to *M. subrotunda* of Montagu; but, as Millett has already remarked, with regard to his series from the Malay Archipelago,* the variations undoubtedly belong to the species

* *Journ. R. Micr. Soc.*, 1898, p. 500.

M. circularis, distinguished by certain fundamental characters common to all three varieties. A typical example of *M. subrotunda*, however, occurs in the Shoreham gathering.

A.B., very rare; M.H., very rare; T., rare.

Miliolina circularis, Bornemann sp.; var. **sublineata**, Brady.

M. circularis, Born. sp.: var. *sublineata*, Brady, 1884, *Rep. Chall.*, vol. ix., p. 169, pl. iv., fig. 7; Millett, 1898, *Journ. R. Micr. Soc.*, p. 501, pl. xi., fig. 4.

The Victorian shell shows the simple crescentic aperture of the type form, and is distinguished by its delicately lineated surface. The examples recorded by Millett from the Malay Archipelago are of much stouter build, and possess cribrate apertures.

M.H., very rare.

Miliolina valvularis, Reuss sp.

Triloculina valvularis, Reuss, 1851, *Zeitschr. d. deutsch. geol. Gesellsch.*, vol. iii., p. 85, pl. vii., fig. 56.

Miliolina valvularis, Rss. sp.; Millett, 1898, *Journ. R. Micr. Soc.*, p. 501, pl. xi., figs. 5—7.

B., very rare; M.H., very rare; Sh., very rare; T., very rare.

Miliolina dilatata, d'Orbigny sp.

Quinqueloculina dilatata, d'Orbigny, 1839, *Foram. Cuba*, p. 192, pl. ix., figs. 28—30; Schlumberger, 1893, *Mem. Soc. Zool. France*, vol. vi., p. 217, fig. 30, and pl. iii., figs. 73, 74.

This species seems to be closely related to the preceding, and may be only a depressed discoidal variety of it. Parker and Jones record *M. dilatata* from the Melbourne shore-sands.

M.H., very rare.

Miliolina labiosa, d'Orbigny sp.

(Pl. 9, Fig. 2.)

Triloculina labiosa, d'Orbigny, 1839, *Foram. Cuba*, p. 178, pl. x., figs. 12—14.

Miliolina labiosa, d'Orb. sp.; Millett, 1898, *Journ. R. Micr. Soc.*, p. 502, pl. xi., figs. 8, 9.

The remarks by Millett with regard to the Malayan specimens apply equally to the Victorian.

M.H., very rare; T., very common.

Miliolina subrotunda, Montagu sp.

Vermiculum subrotundum, Montagu, 1803, *Test. Brit.*, pt. ii., p. 521.

Miliolina subrotunda, Mont. sp.; Jones, 1895, *Foram. Crag* (*Pal. Soc. Mon.*), p. 120, woodcut, fig. 9.

A.B., very rare; Sh., very rare.

Miliolina tricarinata, d'Orbigny sp.

Triloculina tricarinata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 299, No 7.

Miliolina tricarinata, d'Orb. sp.; Brady, 1884, *Rep. Chall.*, vol. ix., p. 165, pl. iii., figs. 17, *a*, *b*.

B., small and very rare.

Miliolina trigonula, Lamarck sp.

Miliolites trigonula, Lamarck, 1804, *Ann. du Museum*, vol. v., p. 351, No. 3.

Miliolina trigonula Lam. sp.; Goës, 1894, *Kongl. Svenska Vet.-Akad. Handl.*, vol. xxv., p. 115, pl. xxii., fig. 870.

M.H., frequent; Sh., frequent; T., very rare.

Miliolina seminulum, Linn. sp.

Serpula seminulum, Linné, 1767, *Syst. Nat.*, 12th ed., p. 1264, No. 791.

Miliolina seminulum, Linn. sp.; Sidebottom, 1904, *Mem. and Proc. Manchester Lit. and Phil. Soc.*, vol. xlviii., pt. ii., p. 10.

Our specimens, from Beaumaris, have rounded and polished convolutions and the test is of the elongated variety, approaching *M. oblonga*.

A.B., common; B., very common; M.H., very rare.

Miliolina vulgaris, d'Orbigny sp.

Quinqueloculina vulgaris, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 302, No. 33; Schlumberger, 1893, *Bull. Soc. géol. France*, vol. vi., p. 65, figs. 13, 14; pl. ii., figs. 65, 66.

A.B., very rare; B., rare; Sh., very rare, specimens small.

Miliolina cuvieriana, d'Orbigny sp.

Quinqueloculina cuvieriana, d'Orbigny, 1839, *Foram. Cuba*, p. 190, pl. xi., figs. 19—21.
Miliolina cuvieriana, d'Orb. sp.; Millett, 1898, *Journ. R. Micr. Soc.*, p. 505, pl. xii., figs. 2, *a*, *b*.

A.B., rare; M.H., very rare.

Miliolina venusta, Karrer sp.

Quinqueloculina venusta, Karrer, 1868, *Sitzungsb. d. k. Akad. Wiss. Wien*, vol. lviii., p. 147, pl. ii., fig. 6.

A.B., rare; B., rare; M.H., very rare.

Miliolina undosa, Karrer sp.

Quinqueloculina undosa, Karrer, 1867, *Sitzungsb. d. k. Akad. Wiss. Wien*, vol. lv., p. 361, pl. iii., fig. 3.

It is of interest to note that, although this species is commonly found in the neighbourhood of coral reefs, it has also occurred off Moncœur Island, Bass Strait, at 35 fathoms, as well as in the Mediterranean and off Ascension Island.
T., frequent, small.

Miliolina ferussacii, d'Orbigny sp.

Quinqueloculina ferussacii, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 301, No. 18.
Miliolina ferussacii, d'Orb. sp.; Millett, 1898, *Journ. R. Micr. Soc.*, p. 507, pl. xii., figs. 6, *a*, *b*, 7, *a—c*.

Typical specimens of the elongate, strongly costate variety.
Sh., frequent; T., frequent.

Miliolina contorta, d'Orbigny sp.

Quinqueloculina contorta, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 298, pl. xx., figs. 4—6.

A.B., rare; B., rare; Sh., frequent; T., frequent.

Miliolina agglutinans, d'Orbigny sp.

Quinqueloculina agglutinans, d'Orbigny, 1839, *Foram. Cuba*, p. 195, pl. xii., figs. 11—13.

B., rare.

Miliolina bicornis, Walker & Jacob sp.

Serpula bicornis, Walker & Jacob, 1798, in Kanmacher's ed. of *Adam's Essays Microsc.*, p. 633, pl. xiv., fig. 2.
Adelosina bicornis, W. & J. sp.; Schlumberger, 1886, *Bull. Soc. Zool. France*, vol. xi., p. 546, figs. 1—5, and pl. xvi., figs. 10—15.

Specimens not typical, having few and coarse striae.
T., very rare.

Miliolina boueana, d'Orbigny sp.

Quinqueloculina boueana, d'Orbigny, 1846, *Foram. Foss. Vienne*, p 293, pl. xix., figs. 7—9.

A.B., very rare; T., rare.

Sub-family Hauerininae.

Genus **Vertebralina,** d'Orbigny.

Vertebralina striata, d'Orbigny.

Vertebralina striata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 283, No. 1—*Modèle*, No. 81; Millett, 1898, *Journ. R. Micr. Soc.*, p. 607, pl. xiii., fig. 1.

This species was recorded by Parker and Jones from the sand obtained near Melbourne.

B., rare.

Sub-family Peneroplidinae.

Genus **Peneroplis**, Montfort.

Peneroplis pertusus, Forskål sp.

Nautilus pertusus, Forskål, 1775, *Descr. Anim.*, p. 125, No. 65.
Peneroplis pertusus, Fors. sp.; Brady 1884, *Rep. Chall.*, vol. ix., p. 204, pl. xiii., figs. 16, 17.

P.N.; the type-form occurs here. It has already been recorded by Parker and Jones from near Melbourne.

Family LITUOLIDAE.

Sub-family Lituolinae.

Genus **Reophax**, Montfort.

Reophax scorpiurus, Montfort.

R. scorpiurus, Montfort, 1808, *Conch. Syst.*, vol. i., p. 331, 83e genre; Goës, 1894, *K. Svenska Vet.-Akad. Handl.*, vol. xxv., p. 24, pl. v., figs. 158—169.

Sh., very rare.

Genus **Haplophragmium**, Reuss.

Haplophragmium canariense, d'Orbigny sp.

(Pl. 9, Fig. 3.)

Nonionina canariensis, d'Orbigny, 1839, *Hist. Nat. Iles Canaries*, vol. ii., pt. 2, p. 128, pl. ii., figs. 33, 34.

B., very rare; small, compressed form.

Family TEXTULARIIDAE.

Sub-family Textulariinae.

Genus **Textularia**, Defrance.

Textularia conica, d'Orbigny.

T. conica, d'Orbigny, 1839, *Foram. Cuba*, p. 143, pl. i., figs. 19, 20.

B., very rare.

Textularia folium, Parker & Jones.

(Pl. 9, Fig. 4.)

T. folium, Parker & Jones, 1865, *Phil. Trans.*, vol. clv., pp. 370, 420, pl. xviii., fig. 19.

This delicate little species is chiefly confined to coral reefs in the Pacific and Indian Oceans. It was originally described from shore-sand near Melbourne by Parker and Jones, and one of the "Challenger" records is from Bass Straits, 38 fathoms.

M.H., rare.

Genus **Clavulina**, d'Orbigny.

Clavulina parisiensis, d'Orb.; var. **multicamerata**, nov.

(Pl. 9, Fig. 5.)

This variety differs from the type-form in the lowness, and consequently greater width, of the chambers of the later, uniserial part of the test. Since all the specimens met with show this feature, it seems advisable to separate it as a variety or sub-variety.

Sh., moderately rare.

Sub-family Bulimininae.

Genus **Bulimina**, d'Orbigny.

Bulimina elegans, d'Orbigny.

B. elegans, d'Orb., 1826, *Ann. Sci. Nat.*, vol. vii., p. 270, No. 10—*Modèle*, No. 9; Millett, 1900, *Journ. R. Micr. Soc.*, p. 274, pl. ii., fig. 1.

B., rare.

Bulimina buchiana, d'Orbigny.

(Pl. 9, Fig. 6.)

B. buchiana, d'Orb., 1846, *Foram. Foss. Vienne*, p. 186, pl. xi., figs. 15—18.

This species is usually found in moderately deep water.

M.H., very rare, a finely striate variety.

Genus **Bolivina**, d'Orbigny.

Bolivina textilarioides, Reuss.

B. textilarioides, Reuss, 1862 (1863), *Sitzungsb. d. k. Akad. Wiss. Wien*, vol. xlvi., p. 81, pl. x., fig. 1.

B., very rare.

Bolivina punctata, d'Orbigny.

B. punctata, d'Orbigny, 1843, *Foram. Amér. Mérid.*, p. 63, pl. viii., figs. 6—12 ; Flint, 1899, *Rep. U. S. Nat. Mus. for* 1897 p. 292, pl. xxxviii., fig. 1.

B., common.

SUB-FAMILY CASSIDULININAE.

Genus **Cassidulina**, d'Orbigny.

Cassidulina subglobosa, Brady.

C. subglobosa, Brady, 1884, *Rep. Chall.*, vol. ix., p. 430, pl. liv., fig. 17.

B., very rare.

Cassidulina parkeriana, Brady.

(Pl. 9, Fig. 7.)

C. parkeriana, Brady, 1884, *Rep. Chall.*, vol. ix., p. 432, pl. liv., figs. 11—16.

This extremely interesting form has hitherto been found only on the west coast of Patagonia.

M.H., very rare.

FAMILY LAGENIDAE.

SUB-FAMILY LAGENINAE.

Genus **Lagena**, Walker & Boys.

Lagena variata, Brady.

(Pl. 9, Fig. 8.)

L. variata, Brady, 1884, *Rep. Chall.*, vol. ix., p. 461, pl. lxi., fig. 1 ; Millett, 1901, *Journ. R. Micr. Soc.*, p. 7, pl. i., fig. 7.

Previously recorded only off East Moncœur Island, Bass Strait, and from the Malay Archipelago.

B., very rare ; M.H., very rare.

Lagena acuticosta, Reuss, var. **ramulosa**, nov.

(Pl. 9, Fig. 9.)

The test in this variety shows a departure from the typical form * in having ramifying or branching costae. The ribs are prominent and more or less thick and sub-acute; the figured specimen has eleven visible at the base. The neck is tolerably stout and but slightly produced, so that the shell is shaped like a grape-pip.

Length about ·33 mm.

M.H., very rare

Lagena fasciata, Egger sp.

Oolina fasciata, Egger, 1857, *Neues Jahrb. für Min.*, p. 270, pl. v., figs. 12—15.

M.H., very rare.

SUB-FAMILY NODOSARINAE.

Genus **Nodosaria**, Lamarck.

Nodosaria scalaris, Batsch sp.

Nautilus (*Orthoceras*) *scalaris*, Batsch, 1791, *Conch. des Seesandes*, No. 4, pl. ii., fig. 4.

B., rare.

Nodosaria scalaris, Batsch sp., var. **separans**, Brady.

N. scalaris, Batsch. sp., var. *separans*, Brady, 1884, *Rep. Chall.*, vol. ix., p. 511, pl. lxiv., figs. 16—19.

In addition to the only "Challenger" locality, off the west coast of New Zealand, for this variety, Millett recorded it from the Malay Archipelago. It is on this account of special interest to note it from Port Phillip.

B., frequent.

Nodosaria raphanus, Linné sp.

Nautilus raphanus, Linné, 1767, *Syst. Nat.*, 12th ed., p. 1164, No. 283.

B., very rare.

* *L. acuticosta*, Reuss, 1861, *Sitzungsb. d. k. Akad. Wiss. Wien*, vol. xliv., p. 305, pl. i., fig. 4; Millett, 1901, *Journ. Roy. Micr. Soc.*, p. 8.

Nodosaria obliqua, Linné sp., var. **vertebralis,** Batsch var.

Nautilus (*Orthoceras*) *vertebralis*, Batsch, 1791, *Conch. des Seesandes*, p. 3, No. 6, pl. ii., figs. 6, *a*, *b*.

Nodosaria obliqua, Linn. sp., var. *vertebralis*, Batsch; Goës, 1894, *K. Svenska Vet.-Akad. Handl.*, vol. xxv., No. 9, p. 70, pl. xiii., figs. 698, 699; Chapman, 1906, *Trans. N. Z. Inst.*, vol. xxxviii., p. 94, pl. iii., fig. 5.

One example, from the back beach, Sorrento; found by Mr. J. H. Gatliff.

Genus **Marginulina,** d'Orbigny.

Marginulina glabra, d'Orbigny.

M. glabra, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 259, No. 6—*Modèle*, No. 55; Flint, 1899, *Rep. U. S. Nat. Mus. for* 1897 (1899), p. 313, pl. lx., fig. 1.

B., very rare.

Marginulina costata, Batsch sp.

Nautilus (*Orthoceras*) *costatus*, Batsch, 1791, *Conch. des Seesandes*, pl. i., fig. 1.

T., very rare. An elongate variety, with fine riblets.

Genus **Vaginulina,** d'Orbigny.

Vaginulina costata, Cornuel sp.

(Pl. 9, Fig. 10.)

Planularia costata, Cornuel, 1848, *Mém. Soc. géol. France*, sér. 2*a*, vol. iii., p. 253, pl. ii., figs. 5—8.

Vaginulina patens, Brady, 1884, *Rep. Chall.*, vol. ix., p. 533, pl. lxvii., figs. 15, 16.

V. costata, Corn. sp.; Silvestri, 1904, *Atti della Pont. Acc. Rom. dei Nuovi Lincei*, anno lvii., p. 142, woodcuts 3, *a*—*d*.

The only recorded localities for this rare and elegant form are Raine Island, Torres Straits, and the Philippines. One of our specimens differs from Brady's figured examples in having the primordial extremity not developed into a spine (the other example being imperfect); otherwise the test is comparable in all respects, and clearly referable to the species.

B., very rare; T., very rare.

Sub-family Polymorphininae.

Genus **Polymorphina**, d'Orbigny.

Polymorphina lactea, Walker & Jacob sp.

Serpula lactea, Walker & Jacob, 1798 (fide Kanmacher), *Adams' Essays*, 2nd ed., p. 634, pl. xiv., fig. 4.
Polymorphina lactea, W. & J. sp.; Brady, 1884, *Rep. Chall.*, vol. ix., p. 559, pl. lxxi., figs. 11, 14.

A.B., frequent.

Polymorphina lactea, W. & J. sp., fistulose var. **diffusa**, Jones & Chapman.

(Pl. 10, Fig. 1.)

Polymorphina spp., var. *diffusa*, Jones & Chapman, 1896, *Journ. Linn. Soc. Lond.*, vol. xxv., p. 505, figs. 26—29.

T., very rare.

Polymorphina gibba, d'Orbigny.

P. (*Globulina*) *gibba*, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 266, No. 20—*Modèle*, No. 63.

B., very rare.

Polymorphina communis, d'Orbigny.

P. (*Guttulina*) *communis*, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 266, pl. xii., figs. 1—4,—*Modèle*, No. 62.

A.B., frequent; B., common; M.H., very rare.

Polymorphina communis, d'Orb., fistulose var. **marginalis**, Jones & Chapman.

(Pl. 9, Fig. 11.)

Polymorphina spp., var. *marginalis*, Jones & Chapman, 1896, *Journ. Linn. Soc. Lond.*, vol. xxv., p. 506, figs. 30—36.

T., rare.

Polymorphina problema, d'Orbigny.

P. (*Guttulina*) *problema*, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 266, No. 14—*Modèle*, No. 61.

B., very rare.

Polymorphina oblonga, d'Orbigny.

P. oblonga, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 232, pl. xii., figs. 29—31.

A.B., frequent; B., rare.

Polymorphina thouini, d'Orbigny.

(Pl. 10, Fig. 2.)

P. thouini, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 265, No. 8—*Modèle*, No. 23.

Parker and Jones record this species from shore-sand near Melbourne. It has also occurred in the Levant and off East Moncœur Island, Bass Strait.

B., rare.

Polymorphina elegantissima, Parker & Jones.

(Pl. 10, Fig. 3.)

P. elegantissima, Parker & Jones, 1865, *Phil. Trans.*, vol. clv., p. 438; Brady, Parker & Jones, 1870, *Trans. Linn. Soc. Lond.*, vol. xxvii., p. 231, pl. xl., figs. 15, *a—c*.

This handsome species is almost peculiarly Australian, and was originally described from shore-sand near Melbourne by Parker and Jones. It is also of frequent occurrence in the Victorian Tertiary rocks.

A.B., very rare; B., very rare.

Polymorphina regina, Brady, Parker & Jones.

(Pl. 10, Fig. 4.)

P. regina, Brady, Parker & Jones, 1870, *Trans. Linn. Soc. Lond.*, vol. xxvii., p. 241, pl. xli., figs. 32, *a*, *b*.

This species has already occurred, among other localities, at Port Jackson and in Bass Strait.

A.B., common.

Genus **Uvigerina,** d'Orbigny.

Uvigerina angulosa, Williamson.

(Pl. 10, Fig. 5.)

U. angulosa, Williamson, 1858, *Rec. Foram. Gt. Brit.*, p. 67, pl. v., fig. 140.

M.H., a small depauperated example.

Family GLOBIGERINIDAE.

Genus **Globigerina**, d'Orbigny.

Globigerina bulloides, d'Orbigny.

G. bulloides, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 277, No. 1—*Modèles*, Nos. 17, 76.

B., very rare and small ; T., very rare, typical.

Globigerina triloba, Reuss.

G. triloba, Reuss, 1849, *Denkschr. Akad. Wiss. Wien*, vol. i., p. 374, pl. xlvii., fig. 11.

B., rare ; T., rare, typical.

Genus **Orbulina**, d'Orbigny.

Orbulina universa, d'Orbigny.

O. universa, d'Orbigny, 1839, *Foram. Cuba*, p. 3, pl. i., fig. 1.

B., very rare, small.

Genus **Pullenia**, Parker & Jones.

Pullenia quinqueloba, Reuss sp.

Nonionina quinqueloba, Reuss, 1851, *Zeitschr. d. deutsch. geol. Gesellsch.*, vol. iii., p. 47, pl. v., figs. 31, *a*, *b*.

B., very rare.

Family ROTALIDAE.

Sub-family Spirillininae.

Genus **Spirillina**, Ehrenberg.

Spirillina vivipara, Ehrenberg.

S. vivipara, Ehrenberg, 1841, *Abhandl. k. Akad. Wiss. Berlin*, p. 422, pl. iii., fig. 41.

M.H., one typical example.

Spirillina denticulo-granulata, sp. nov.

(Pl. 10, Figs. 6, *a*—*c*.)

Superior face of test showing the entire extent of the coiled spiral, the margin of which is limbate, whilst within the border

the surface is ornamented with a series of depressions or short grooves at right angles to the border, as in *S. limbata*, var. *denticulata*, Brady.* The inferior surface is concave from the inner border of the last whorl, and the surface is almost entirely covered with small granulations. Periphery obtuse or slightly channelled, carinate on the edge of the superior face.

Diameter of test, ·43 mm.; thickness, ·08 mm.

T., very rare.

SUB-FAMILY ROTALINAE.

Genus **Patellina**, Williamson.

Patellina corrugata, Williamson.

(Pl. 10, Fig. 7.)

P. corrugata, Williamson, 1858, *Rec. Foram. Gt. Brit.*, p. 46, pl. iii., figs. 86—89.

The commencement of the test in this species is generally shown as a spiral chamber, or as a Rotaliform embryo with subglobular chambers. Our specimen exhibits a very distinct Rotaline commencement, consisting of nine chambers.

T., very rare.

Genus **Discorbina**, Parker & Jones.

Discorbina turbo, d'Orbigny sp.

Rotalia (Trochulina) turbo, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 274, No. 39—*Modèle*, No. 73.

The tests of this species are generally coloured by the dried protoplasm, and are usually of a brown-pink colour. This species has been already recorded from shore-sand near Melbourne by Parker and Jones.

M.H., common, and rather small; T., rare, rather small.

Discorbina globularis, d'Orbigny sp.

Rosalina globularis, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 271, pl. xiii., figs. 1—4,—*Modèle*, No. 69.

Sh., very rare.

* *Rep. Chall.*, vol. ix., 1884, p. 632, pl. lxxxv., fig. 17.

Discorbina pileolus, d'Orbigny sp.

Valvulina pileolus, d'Orbigny, 1843, *Amér. Mérid. Foram.*, p. 47, pl. i., figs. 15—17.
Discorbina pileolus, d'Orb. sp.; Brady, 1884, *Rep. Chall.*, vol. ix., p. 649, pl. lxxxix., figs. 2—4.

T., very rare.

Discorbina rosacea, d'Orbigny sp.

Rotalia rosacea, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 273, No. 15—*Modèle*, No. 39.
Discorbina rosacea, d'Orb. sp.; Flint, 1899, *Rep. U. S. Nat. Mus. for* 1897 (1899), p. 327, pl. lxxii., fig. 3.

T., rare.

Discorbina opercularis, d'Orbigny sp.

Rosalina opercularis, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 271, No. 7.
Discorbina opercularis, d'Orb. sp.; Brady, 1884, *Rep. Chall.*, vol. ix., p. 650, pl. lxxxix., figs. 8, 9.

T., very rare.

Discorbina bertheloti, d'Orbigny sp.

Rosalina bertheloti, d'Orbigny, 1839, *Foram. Canaries*, vol. ii., pt. 2, p. 135, pl. i., figs. 28—30.
Discorbina bertheloti, d'Orb. sp.; Brady, 1864, *Trans. Linn. Soc.*, vol. xxiv., p. 469, pl. xlviii., fig. 10.

T., very rare.

Discorbina vesicularis, Lamarck sp.

Discorbites vesicularis, Lamarck, 1804, *Ann. du Mus.*, vol. v., p. 183; vol. viii., 1806, pl. lxii., fig. 7.
Discorbina vesicularis, Lam. sp.; Earland, 1905, *Journ. Quekett Micr. Club*, p. 224, pl. xii., figs. 9, 10; pl. xiv., fig. 6.

This species has been recorded from shore-sand near Melbourne by Parker and Jones.

Sh., rare.

Discorbina dimidiata, Jones & Parker.

(Pl. 10, Figs. 8, *a*, *b*.)

D. dimidiata, Jones & Parker, 1862, in Carpenter, Parker, & Jones' *Introd. Foram.*, p. 201, fig. xxxii. B ; Parker & Jones, 1865, *Phil. Trans.*, vol. clv., pp. 385, 422, pl. xix., figs. 9, *a*—*c*.

This peculiarly Australian species, regarded by Parker and Jones as a sharp-edged, inferiorly concave modification of *D. vesicularis*, is one of the most abundant of the shore-sand Foraminifera on the southern coast. The test is of a reddish brown colour, and darker in the apical region. By its more turgid form and coarsely perforated shell-wall we can easily distinguish it from *D. rosacea*, d'Orb. The original locality is shore-sand near Melbourne ; and Howchin records it from the north arm of the Port Adelaide River.

A.B., very common ; B., very common ; M.H., very common ; P.N. ; Sh., common ; T., common.

Discorbina rugosa, d'Orbigny sp.

Rosalina rugosa, d'Orbigny, 1843, *Amér. Mérid. Foram.*, p. 42, pl. ii., figs. 12—14.

Sh., rare.

Discorbina biconcava, Jones & Parker.

D. biconcava, Jones & Parker, 1862, in Carpenter's *Introd. Foram.*, p. 201, fig. xxxii. G ; Parker & Jones, 1865, *Phil. Trans.*, vol. clv., pp. 385, 422, pl. xix., figs. 10, *a*—*c*.

This species is interesting from the fact that it occurs almost exclusively around the Australian coast, having been found off East Moncœur Island, Bass Straits, Storm Bay, Tasmania, and Raine Island, Torres Straits. It has also been recorded from shore-sand near Melbourne by Parker and Jones. The only exception to the Australian localities for this species seems to be that given by J. D. Siddall, who found it in the estuary of the Dee.

M.H., rare ; T., frequent.

Discorbina rarescens, Brady.

D. rarescens, Brady, 1884, *Rep. Chall.*, vol. ix., p. 651, pl. xc., figs. 2—4.

T., very rare.

Discorbina valvulata, d'Orbigny sp.

Rosalina valvulata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 271, No. 4.

Discorbina valvulata, d'Orb. sp.; Goës, 1882, *K. Svenska Vet.-Akad. Handl.*, vol. xix., No. 4, p. 106, pl. viii., figs. 258—261.

T., rare.

Genus **Planorbulina**, d'Orbigny.

Planorbulina mediterranensis, d'Orbigny.

P. mediterranensis, d'Orb., 1826, *Ann. Sci. Nat.*, vol. vii., p. 280, pl. xiv., figs. 4—6,—*Modèle*, No. 79.

Recorded by Parker and Jones in the Melbourne list as *Planorbulina vulgaris*, d'Orb.

B., very rare, small; T., common, well-grown individuals with initial series of chambers of a brown-pink colour.

Genus **Truncatulina**, d'Orbigny.

Truncatulina lobatula, Walker & Jacob sp.

Nautilus lobatulus, Walker & Jacob, 1798, *Adams' Essays*, Kanmacher's ed., p. 642, pl. xiv., fig. 36.

This generally abundant species of the littoral zone is conspicuously rare in the Victorian gatherings, and examples are below the average size.

B., rare; T., very rare.

Truncatulina refulgens, Montfort sp.

Cibicides refulgens Montfort, 1808, *Conch. Syst.*, vol. i., p. 122, 31e genre.

Truncatulina refulgens, Montf. sp.; Egger, 1899, *Abhandl. k. bayer. Akad. Wiss.*, Cl. II., vol. xxi., p. 151, pl. xx., figs. 20, 21.

T., very rare and dwarfed.

Truncatulina haidingeri, d'Orbigny sp.

Rotalina haidingeri, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 154, pl. viii., figs. 7—9.

B., very rare and small; T., rare, but typical.

Truncatulina ungeriana, d'Orbigny sp.

Rotalina ungeriana, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 157, pl. viii., figs. 16—18.

B., frequent, rather small; T., very rare.

Genus **Anomalina,** d'Orbigny.

Anomalina ammonoides, Reuss sp.

Rosalina ammonoides, Reuss, 1845, *Verstein. böhm. Kreidef.*, p. 36, pl. viii., fig. 53; pl. xiii., fig. 66.

Anomalina ammonoides, Reuss sp.; Brady, 1884, *Rep. Chall.*, vol. ix., p. 672, pl. xciv., figs. 2, 3.

This species was recorded by Parker and Jones from the shore-sand near Melbourne.

M.H., very rare, typical; T., very rare, small.

Anomalina polymorpha, Costa.

A. polymorpha, Costa, 1856, *Atti dell' Accad. Pontan.*, vol. vii., p. 252, pl. xxi., figs. 7—9.

This species has not hitherto been recorded from this part of the Australian coast. It was found, however, by the "Challenger" off Sydney, at 410 fathoms.

B., very rare, rather small.

Genus **Pulvinulina,** Parker & Jones.

Pulvinulina repanda, Fichtel & Moll sp.

Nautilus repandus, Fichtel & Moll, 1798, *Test Micr.*, p. 35, pl. iii., figs. *a*—*d*.

Pulvinulina repanda, F. & M. sp.; Flint, 1899, *Rep. U. S. Nat. Mus. for* 1897 (1899), p. 328, pl. lxxii., fig. 8.

M.H., rare, small; Sh., frequent, small; T., frequent, typical.

Pulvinulina brongniartii, d'Orbigny sp.

Rotalia brongniartii, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 273, No. 27.

Pulvinulina brongniartii, d'Orb. sp.; Millett, 1904, *Journ. Roy. Micr. Soc.*, p. 498, pl. x., fig. 4.

Egger found this species in the "Gazelle" dredgings off Western Australia at 90—359 metres. The examples from the Malay

Archipelago are recorded by Millett as having persistent characters and occurring abundantly.

M.H., rare and small, but otherwise typical.

Pulvinulina punctulata, d'Orbigny sp.

Rotalia punctulata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 273, No. 25—*Modèle*, No. 12.

B., very rare and small.

Pulvinulina elegans, d'Orbigny sp.

Rotalia (Turbinulina) elegans, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 276, No. 54.

B., rare, weak examples.

Genus **Rotalia**, Lamarck.

Rotalia beccarii, Linné sp.

Nautilus beccarii, Linné, 1767, *Syst. Nat.*, 12th ed., p. 1162; 1788, *ibid.*, 13th (Gmelin's) ed., p. 3370, No. 4.

Rotalia beccarii, Linné sp.; Chapman, 1902, *The Foraminifera*, p. 37, fig. 23.

This typically estuarine species attains its best development at Altona Bay, near to where the Kororoit Creek enters the sea. Howchin records it from the Port Adelaide River.

A.B., very common, well developed in point of size; B., common, tests small, thin, and translucent, but otherwise typical; M.H., frequent, small; T., rare, of normal size.

Rotalia papillosa, var. **compressiuscula**, Brady.

R. papillosa, var. *compressiuscula*, Brady, 1884, *Rep. Chall.*, vol. ix., p. 708, pl. cvii., figs. 1, *a—c*; pl. cviii., figs. 1, *a—c*.

This variety has been found in shallow-water dredgings chiefly in the Pacific. The nearest locality to the present one is Port Jackson, Sydney. It is just possible, however, that the examples before us may have been derived from the Tertiary fossiliferous cliffs at Beaumaris, since they are somewhat iron-stained, and the species has been recorded as a Victorian fossil.

B., very rare.

Rotalia soldanii, d'Orbigny.

R. (*Gyroidina*) *soldanii*, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 278, No. 5—*Modèle*, No. 36.

This species is almost essentially a deep-water form.

M.H., very rare, specimens small.

Rotalia calcar, d'Orbigny.

Calcarina calcar, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 276, No. 1—*Modèle*, No. 34.

Rotalia calcar, d'Orbigny sp.; Egger, 1893, *Abhandl. k. bayer. Akad. Wiss.*, Cl. II., vol. xviii., p. 423, pl. xix., figs. 1—3.

The above species does not appear to have been recorded before from Australian waters, the nearest locality being the Malay Archipelago, where it was found by Millett associated with, and merging into, the species *R. venusta*, Brady.

A.B., very rare.

Rotalia clathrata, Brady.

R. clathrata, Brady, 1884, *Rep. Chall.*, vol. ix., p. 709, pl. cvii., figs. 8, 9.

This species has been previously obtained between Bass Strait and New Zealand, as well as off the west coast of Patagonia.

T., rare, typical.

Sub-family Tinoporinae.

Genus **Gypsina**, Carter.

Gypsina inhaerens, Schultze sp.

Acervulina inhaerens, Schultze, 1854, *Organ. der Polythal.*, p. 68, pl. vi., fig. 12.

Gypsina inhaerens, Schultze sp.; Goës, 1894, *K. Svenska Vet.-Akad. Handl.*, vol. xxv., p. 91, pl. xv., fig. 787.

This species appears to be rare in the southern hemisphere. It has been recorded by the "Challenger," among other places, off East Moncœur Island, Bass Strait.

Sh., very rare; T., very rare.

Gypsina vesicularis, Parker & Jones sp.

Orbitolina vesicularis, Parker & Jones, 1860, *Ann. and Mag. Nat. Hist.*, ser. 3, vol. vi., p. 31, No. 5.

Gypsina vesicularis, Parker & Jones sp.; Egger, 1893, *Abhandl. k. bayer. Akad. Wiss.*, Cl. II., vol. xviii., p. 382, pl. xiv., figs. 20—23; Chapman, 1900, *Journ. Linn. Soc.* (*Zool.*), p. 198, pl. xix., fig. 12.

Sh., very rare; T., very rare.

Family NUMMULINIDAE.

Sub-family Polystomellinae.

Genus **Nonionina**, d'Orbigny.

Nonionina depressula, Walker & Jacob sp.

Nautilus depressulus, Walker & Jacob, 1798, *Adams' Essays*, Kanmacher's ed., p. 641, pl. xiv., fig. 33.

Nonionina depressula, W. & J. sp.; Wright, 1900, *Geol. Mag.*, Dec. 4, vol. vii., p. 100, pl. v., fig. 23.

B., very rare.

Genus **Polystomella**, Lamarck.

Polystomella striatopunctata, Fichtel & Moll sp.

Nautilus striatopunctatus, Fichtel & Moll, 1798, *Test. Micr.*, p. 61, pl. ix., figs. *a*—*c*.

Polystomella striatopunctata, F. & M. sp.; Wright, 1900, *Geol. Mag.*, Dec. 4, vol. vii., p. 100, pl. v., fig. 24.

The Victorian examples are generally distinct from the allied form *P. macella*, but transitional individuals are occasionally met with, having laterally compressed shells with a sharp periphery.

A.B., frequent; B., very rare; M.H., rare; T., very rare.

Polystomella macella, Fichtel & Moll sp.

Nautilus macellus, var. *a*, Fichtel & Moll, 1798, *Test. Micr.*, p. 66, pl. x., figs. *e*—*g*.

Polystomella macella, F. & M. sp.; Brady, 1884, *Rep. Chall.*, vol. ix., p. 737, pl. cx., figs. 8, 9.

Previously recorded from shore-sand near Melbourne. The Victorian examples are usually irregular on the peripheral margin, thus resembling to some extent Brady's *P. imperatrix*, but without the occasional, strong spines.

A.B., frequent; B., frequent; M.H., very rare; Sh., rare; T., very common.

Polystomella macella, F. & M. sp., var. **limbata**, nov.

(Pl. 10, Figs. 9, *a*, *b*.)

This variety is like the specific form in having a depressed umbilicus and subacute periphery; the sutures, however, instead of being excavated, are prominent, and the shell surface near the sutural areas and over the umbilical region is covered with an exogenous shell-growth in the form of small papillae or granulations.

A.B., frequent; B., very common.

Polystomella crispa, Linné sp.

Nautilus crispus, Linné, 1767, *Syst. Nat.*, 12th ed., pp. 1162, 275.
Polystomella crispa, Linn. sp.; Flint, 1899, *Rep. U. S. Nat. Mus. for* 1897 (1899), p. 338, pl. lxxx., fig. 3.

Some of the examples from Altona Bay and Beaumaris exhibit spinose outgrowths on the periphery at the sutural angle.

A.B., common; B., frequent; M.H., frequent; P.N., one specimen; Sh., frequent; T., frequent.

Polystomella subnodosa, Münster sp.

Robulina subnodosa, Münster (fide Römer), 1838, *Neues Jahrb. für Min.*, p. 39, pl. iii., fig. 61.
Polystomella subnodosa, Münster sp.; Goës, 1894, *K. Svenska Vet.-Akad. Handl.*, vol. xxv., p. 102, pl. xvii., figs. 817—819.

A.B., rare; B., frequent; M.H., rare; Sh., very rare; T., rare.

Polystomella verriculata, Brady.

(Pl. 10, Fig. 10.)

P. verriculata, Brady, 1881, *Quart. Journ. Micr. Sci.*, vol. xxi., N.S., p. 66; id., 1884, *Rep. Chall.*, vol. ix., p. 738, pl. cx., figs. 12, *a*, *b*.

This is almost essentially an Australian species. It has been recorded off East Moncœur Island, Bass Strait, and in Curtis Strait, Queensland, by Dr. H. B. Brady; these localities, by the way, are off the south and east coasts, and not the west coast of Australia, as stated by that author. Millett records this species from the Malay Archipelago and from Sagami Bay, Japan.

B., very rare.

Distribution List of Victorian Foraminifera.

—	Altona Bay.	Beaumaris.	McHaffie's Reef.	Point Nepean.	Shoreham.	Sorrento.	Torquay.
1. *Nubecularia bradyi*, Millett	...	...	*r.*	...	...	...	*v.c.*
2. *Biloculina depressa*, d'Orbigny	...	...	...	...	*v.r.*	...	...
3. *Spiroloculina nitida*. „	...	...	*v.r.*	...	*v.r.*	...	...
4. „ *grata*, Terq.	*f.*	*f.*	...	...	...	...	...
5. *Miliolina oblonga*, Mont. sp.	*c.*	*v.c.*	*v.r.*	...	...	...	*f.*
6. „ *bosciana*, d'Orb. sp.	*c.*	*v.c.*	*v.r.*	...	...	...	...
7. „ *rotunda*, „	*v.r.*	...	...	...	*v.r.*	...	...
8. „ *circularis*, Born. sp.	*v.r.*	...	*v.r.*	...	...	...	*r.*
9. „ „ var. *sublineata*, Brady	...	...	*v.r.*	...	...	...	...
10. „ *valvularis*, Reuss sp.	...	*v.r.*	*v.r.*	...	*v.r.*	...	*v.r.*
11. „ *dilatata*, d'Orb. sp.	...	...	*v.r.*	...	...	...	...
12. „ *labiosa*, „	...	...	*v.r.*	...	...	...	*v.c.*
13. „ *subrotunda*, Mont. sp.	*v.r.*	...	...	...	*v.r.*	...	...
14. „ *tricarinata*, d'Orb. sp.	...	*v.r.*	...	...	...	...	...
15. „ *trigonula*, Lam. sp.	...	...	*f.*	...	*f.*	...	*v.r.*
16. „ *seminulum*, Linn. sp.	*c.*	*v.c.*	*v.r.*	...	...	...	...
17. „ *vulgaris*, d'Orb. sp.	*v.r.*	*r.*	...	...	*v.r.*	...	...
18. „ *cuvieriana*, „	*r.*	...	*v.r.*	...	...	...	...
19. „ *venusta*, Karrer sp.	*r.*	*r.*	*v.r.*	...	...	...	...
20. „ *undosa*, „	...	...	...	...	...	...	*f.*
21. „ *ferussacii*, d'Orb. sp.	...	...	...	...	*f.*	...	*f.*
22. „ *contorta*, „	*r.*	*r.*	...	...	*f.*	...	*f.*
23. „ *agglutinans*, „	...	*r.*	...	...	...	...	...
24. „ *bicornis*, W. & J. sp.	...	...	...	...	...	...	*v.r.*
25. „ *boueana*, d'Orb. sp.	*v.r.*	...	...	...	...	...	*r.*
26. *Vertebralina striata*, d'Orbigny	...	*r.*	...	...	...	...	...
27. *Peneroplis pertusus*, Fors. sp.	...	...	...	×	...	...	...
28. *Reophax scorpiurus*, Mont.	...	...	...	...	*v.r.*	...	...
29. *Haplophragmium canariense*, d'Orb. sp.	...	*v.r.*	...	...	...	...	...
30. *Textularia conica*, d'Orb.	...	*v.r.*	...	...	...	...	...
31. „ *folium*, P. & J.	...	...	*r.*	...	...	...	...
32. *Clavulina parisiensis*, d'Orb., var. *multicamerata* nov.	...	...	...	...	*r.*	...	...
33. *Bulimina elegans*, d'Orb.	...	*r.*	...	...	...	...	...
34. „ *buchiana*, „	...	...	*v.r.*	...	...	...	...
35. *Bolivina textilarioides*, Reuss.	...	*v.r.*	...	...	...	...	...
36. „ *punctata*, d'Orb.	...	*c.*	...	...	...	...	...
37. *Cassidulina subglobosa*, Brady	...	*v.r.*	...	...	...	...	...
38. „ *parkeriana*, „	...	...	*v.r.*	...	...	...	...
39. *Lagena variata*, „	...	*v.r.*	...	...	...	...	...
40. „ *acuticosta* Rss., var. *ramulosa*, nov.	...	...	*v.r.*	...	...	...	...
41. „ *fasciata*, Egger sp.	...	...	*v.r.*	...	...	...	...
42. *Nodosaria scalaris*, Batsch sp.	...	*r.*	...	...	...	...	...
43. „ „ var. *separans* Brady	...	*f.*	...	...	...	...	...
44. „ *raphanus*, Linn. sp.	...	*v.r.*	...	...	...	...	...

—	Altona Bay.	Beaumaris.	McHaffie's Reef.	Point Nepean.	Shoreham.	Sorrento.	Torquay.
45. *Nodosaria obliqua*, Linn. sp. var. *vertebralis*, Batsch var.	...	...	...	...	...	×	...
46. *Marginulina glabra*, d'Orb. . .	...	*v.r.*	...	...	...	...	...
47. ,, *costata*, Batsch sp. .	...	...	...	...	...	...	*v.r.*
48. *Vaginulina* ,, Cornuel sp. .	...	*v.r.*	...	...	...	...	*v.r.*
49. *Polymorphina lactea*, W. & J. sp. .	*f.*	...	...	...	...	...	...
50. ,, ,, var. *diffusa*, J. & C. .	...	...	...	...	...	...	*v.r.*
51. ,, *gibba*, d'Orb. . .	...	*v.r.*	...	...	...	...	...
52. ,, *communis*, d'Orb. .	*f.*	*c.*	*v.r.*	...	...	...	...
53. ,, ,, var. *marginalis* J. & C.	...	...	...	...	...	...	*r.*
54. ,, *problema*, d'Orb. .	...	*v.r.*	...	...	...	...	...
55. ,, *oblonga*, ,, .	*f.*	*r.*	...	...	...	...	...
56. ,, *thouini*, ,, .	...	*r.*	...	...	...	...	...
57. ,, *elegantissima*, P. & J.	*v.r.*	*v.r.*	...	...	...	...	...
58. ,, *regina*, B., P., & J. .	*c.*	...	...	...	...	...	...
59. *Uvigerina angulosa*, Will. . .	...	...	*v.r.*	...	...	...	...
60. *Globigerina bulloides*, d'Orb. . .	...	*v.r.*	...	...	...	...	*v.r.*
61. ,, *triloba*, Reuss . .	...	*r.*	...	...	...	...	*r.*
62. *Orbulina universa*, d'Orb. . .	...	*v.r.*	...	...	...	...	...
63. *Pullenia quinqueloba*, Rss. sp. . .	...	*v.r.*	...	...	...	...	...
64. *Spirillina vivipara*, Ehren. . .	...	...	*v.r.*	...	...	...	...
65. ,, *denticulo-granulata*, sp. nov.	...	...	...	...	...	...	*v.r.*
66. *Patellina corrugata*, Will. . .	...	...	...	...	...	...	*v.r.*
67. *Discorbina turbo*, d'Orb. sp. . .	...	...	*c.*	...	...	...	*r.*
68. ,, *globularis*, ,, . .	...	...	...	...	*v.r.*	...	...
69. ,, *pileolus*, ,, . .	...	...	...	...	...	...	*v.r.*
70. ,, *rosacea*, ,, . .	...	...	...	...	...	...	*r.*
71. ,, *opercularis*, ,, . .	...	...	..	...	...	...	*v.r.*
72. ,, *bertheloti*, ,, . .	...	...	...	...	...	...	*v.r.*
73. ,, *vesicularis*, Lam. sp. .	...	...	...	...	*r.*	...	...
74. ,, *dimidiata*, J. & P. . .	*v.c.*	*v.c.*	*v.c.*	×	*c.*	...	*c.*
75. ,, *rugosa*, d'Orb. sp. . .	...	...	...	...	*r.*	...	...
76. ,, *biconcava*, J. & P. . .	...	..	*r.*	...	...	...	*f.*
77. ,, *rarescens*, Brady . .	...	...	...	...	...	...	*v.r.*
78. ,, *valvulata*, d'Orb. sp. .	...	...	...	...	...	...	*r.*
79. *Planorbulina mediterranensis*, d'Orb.	...	*v.r.*	...	...	...	...	*c.*
80. *Truncatulina lobatula*, W. & J. sp .	...	*r.*	...	...	...	...	*v.r.*
81. ,, *refulgens*, Mont. sp. .	...	...	...	...	...	...	*v.r.*
82. ,, *haidingeri*, d'Orb. sp.	...	*v.r.*	...	...	...	...	*r.*
83. ,, *ungeriana*, ,, .	...	*f.*	...	...	...	...	*v.r.*
84. *Anomalina ammonoides*, Rss. sp. .	...	...	*v.r.*	...	...	...	*v.r.*
85. ,, *polymorpha*, Costa . .	...	*v.r.*	...	...	...	...	...
86. *Pulvinulina repanda*, F. & M. sp. .	...	...	*r.*	...	*f.*	...	*f.*
87. ,, *brongniartii*, d'Orb. sp.	...	...	*r.*	...	...	...	...
88. ,, *punctulata*, ,, .	...	*v.r.*	...	...	...	...	...
89. ,, *elegans*, ,, .	...	*r.*	...	...	...	...	...
90. *Rotalia beccarii*, L. sp. . . .	*v.c.*	*c.*	*f.*	...	...	...	*r.*
91. ,, *papillosa*. var. *compressiuscula*, Brady . . .	...	*v.r.*	...	...	...	...	...

—	Altona Bay.	Beaumaris.	McHaffie's Reef.	Point Nepean.	Shoreham.	Sorrento.	Torquay.
92. *Rotalia soldanii*, d'Orb.	...	...	*v.r.*	...	...	...	...
93. „ *calcar*, d'Orb. sp.	*v.r.*	...	...	...	...	...	...
94. „ *clathrata*, Brady	...	...	...	...	...	...	*r.*
95. *Gypsina inhaerens*, Schultze sp.	...	...	...	...	*v.r.*	...	*v.r.*
96. „ *vesicularis*, P. & J. sp.	...	...	...	...	*v.r.*	...	*v.r.*
97. *Nonionina depressula*, W. & J. sp.	...	*v.r.*	...	...	...	...	...
98. *Polystomella striatopunctata*, F. & M. sp.	*f.*	*v.r.*	*r.*	...	...	...	*v.r.*
99. „ *macella*, F. & M. sp.	*f.*	*f.*	*v.r.*	...	*r.*	...	*v.c.*
100. „ „ var. *limbata*, nov.	*f.*	*v.c.*	...	...	...	...	...
101. „ *crispa*, Linn. sp.	*c.*	*f.*	*f.*	×	...	...	...
102. „ *subnodosa*, Münster sp.	*r.*	*f.*	*r.*	...	*v.r.*	...	*r.*
103. „ *verriculata*, Brady.	...	*v.r.*	...	...	...	...	...

Explanation of Plates 9 and 10.

Plate 9.

Fig. 1. *Spiroloculina nitida*, d'Orbigny, McHaffie's Reef, Phillip Island.

„ 2. *Miliolina labiosa*, d'Orbigny sp., Torquay.

„ 3. *Haplophragmium canariense*, d'Orbigny sp., Beaumaris.

„ 4. *Textularia folium*, Parker & Jones, McHaffie's Reef.

„ 5. *Clavulina parisiensis*, d'Orbigny, var. *multicamerata*, nov., Shoreham, Western Port.

„ 6. *Bulimina buchiana*, d'Orbigny, McHaffie's Reef.

„ 7. *Cassidulina parkeriana*, Brady, „ „

„ 8. *Lagena variata*, Brady, Beaumaris.

„ 9. „ *acuticosta*, Reuss, var. *ramulosa*, nov., McHaffie's Reef.

„ 10. *Vaginulina costata*, Cornuel sp., Beaumaris.

„ 11. *Polymorphina communis*, d'Orbigny, var. *marginalis*, Jones & Chapman, Torquay.

All figures magnified 44 diameters.

Plate 10.

Fig. 1. *Polymorphina lactea*, W. & J. sp., var. *diffusa*, Jones & Chapman, Torquay, × 44.
,, 2. ,, *thouini*, d'Orbigny, Beaumaris, × 44.
,, 3. ,, *elegantissima*, Parker & Jones, Beaumaris, × 44.
,, 4. ,, *regina*, Brady, Parker, & Jones, Altona Bay, × 44.
,, 5. *Uvigerina angulosa*, Williamson, McHaffie's Reef, × 44.
,, 6, *a—c*. *Spirillina denticulo-granulata*, sp. nov., Torquay, × 44.
,, 7. *Patellina corrugata*, Williamson, apical part of test, Torquay, × 88.
,, 8, *a*, *b*. *Discorbina dimidiata*, Parker & Jones, McHaffie's Reef, × 44.
,, 9, *a*, *b*. *Polystomella macella*, F. & M. sp., var. *limbata*, nov., Altona Bay, × 44.
,, 10. ,, *verriculata*, Brady, Beaumaris, × 33.

ON BRACHIONUS SERICUS, n. sp., A NEW VARIETY OF BRACHIONUS QUADRATUS, AND REMARKS ON BRACHIONUS RUBENS, OF EHRENBERG.

By Charles F. Rousselet, F.R.M.S.

Read June 21st, 1907.

Plates 11 and 12.

Brachionus sericus, n. sp.

Ever since 1895 I have been acquainted with a species of *Brachionus* which appeared to be new, but which I did not then describe as such owing to the confusion produced in my mind by the inaccuracies in the published figures of some of the old species. Having in the meantime seen and studied most of the known species of *Brachionus* and their varieties, I am able to add the above as a good new species to the Rotatorian fauna under the name of *Brachionus sericus*, Fig. 1, Pl. 11.

The specific characters may be stated as follows:

Lorica with six nearly equal, straight occipital teeth, with shallow median sinus; mental edge ondulate, with rounded notch in the middle; lorica rising posteriorly to form an overhanging border, which may be either simply rounded, or may extend to form a considerable pointed projection; lorica covered all over with fine longitudinal wavy lines, giving the appearance of "watered silk."

My first acquaintance with this new species occurred in May, 1895, when I found it in one of the Totteridge ponds which we visited in the course of a Quekett excursion. Afterwards I obtained it sparingly in various places around London, particularly in Epping Forest, usually in small ponds full of decaying leaves, with clear brownish water; and Mr. Scourfield sent it to me this spring from Snaresbrook. It has also been sent to me

from several places in the country, by Mr. John Hood from the neighbourhood of Dundee, and by Mr. John Stevens from Exeter.

In July, 1897, at the Club's excursion to Hertford Heath, I found a remarkable variety of this species, in which the dorsal plate extends posteriorly into a high and long projecting point, as represented in Figs. 2 and 3, Pl. 11.

In general appearance *B. sericus* resembles *B. urceolaris*, and no doubt has before now been mistaken for this species. On closer examination, however, it will be found that the structure of the lorica is very different. The whole of the lorica, including the ventral plate, is covered with very fine, regular, longitudinal wavy lines, which give it the appearance of "watered silk"; hence the name *sericus*. From certain points of view the basal plate has the appearance of being pitted, which Mr. Dixon-Nuttall (to whom I am once more indebted for the excellent figures on Pl. 11) has indicated in his drawing; but it seems to me that this appearance is due to the foreshortening of the wavy markings.

The high and rounded, or more or less pointed, dorso-posterior edge of the lorica overhangs the basal plate, forming here a recess in which the eggs are usually carried. Anteriorly the six teeth are nearly equal in length, the "antlers" being only slightly longer than the outer teeth, and the sinus between them is less deep than in *B. rubens* or *urceolaris*; the four inner teeth have each a short strengthening ridge. The mental edge is ondulate, with a rounded sinus in the middle. The foot opening is rounded or conical in shape in the ventral plate, and square in the basal plate on the upper side.

The greatest variation occurs in the dorso-posterior edge of the lorica, which, whilst always overhanging, may be simply rounded or prolonged into an obtuse point; or again, as in the Hertford Heath specimens, it may be extended into a very considerable pointed prolongation (Figs. 2 and 3), which gives these animals a

very different appearance from the type. As, however, intermediate forms occur, it seems unnecessary to make even a variety of these extreme forms.

The internal anatomy is quite normal, and follows that of *B. urceolaris*. The foot is long and wrinkled, except a short distal piece, which carries the two small conical toes.

The usual three kinds of eggs have been observed; the small male eggs and larger female eggs have the usual structure; the fertilised resting egg is broader at one end and has a thick shell which is deeply pitted, and the rounded contents inside only fills about half the cavity of the eggshell.

The male was obtained by isolating and hatching some male eggs; it has the usual characters of the *Brachionus* males, and its integument is but slightly chitinised; Fig. 4, Pl. 11, drawn by Mr. Dixon-Nuttall from a preserved specimen, gives a good idea of its appearance.

Size of lorica: female, length 292 μ ($\frac{1}{87}$ in.), width 231 μ ($\frac{1}{110}$ in.); size of male, 120 μ ($\frac{1}{210}$ in.): of resting egg 136 μ ($\frac{1}{185}$ in.); female egg 110 μ ($\frac{1}{230}$ in.).

Brachionus quadratus var. **rotundus**, n. var.

Since the discovery of *B. quadratus* in 1889, I have found this species in many localities around London, and often in considerable numbers in the Regent's Canal. It has also been sent to me from various parts of England, so that it is evidently a widely distributed species. Bilfinger has recorded it from Württemberg, and in 1905 I collected it in the Koorn Spruit, Orange River Colony, in South Africa.

Some two years ago Mr. John Wood sent me from Dundee a *Brachionus* which he could not name, but which I soon recognised by the peculiar lace-like structure of the lorica as a remarkable variety of *B. quadratus*, in which the sharp posterolateral corners of the type species have become rounded off, as

shown in Fig. 6. I have therefore named this *B. quadratus* var. *rotundus*. A second difference to be noted is that the median of the three spines guarding the foot opening is reduced to a rounded projection.

The drawing (Fig. 6) shows a series of fine longitudinal and transverse curved surface markings of the lorica; with the exception of the two median ridges these are really very faint, mere creases in the chitinous integument, and easily overlooked; they are, however, permanent and present also in the type species. The lace-like structure of the lorica is not shown, because it requires much greater magnification to render it visible.

The foot is long, stout at the base and tapering somewhat to the toes; it is transversely wrinkled and also shows the faint pseudo-jointed appearance characteristic of the type species. The small male eggs and larger female eggs are smooth and normal; the fertilised resting egg, however, is very peculiar, oval in shape, and covered all over with closely set stout cylindrical papillae as represented in Fig. 8. I had not seen the resting egg of *B. quadratus* when describing this species in 1889, but have found it since, and it is identical with the above, which is another link connecting the two animals.

The male (Fig. 7) was hatched from male eggs and corresponds in shape and structure to most other males of this genus, the chitinous integument being very thin and flexible.

The internal anatomy of *B. quadratus* var. *rotundus* is quite normal, and requires no further description. The size of lorica is 272 μ ($\frac{1}{93}$ in.), of resting egg 136 μ ($\frac{1}{185}$ in.), of female egg 122 μ ($\frac{1}{210}$ in.), of male egg 75 μ ($\frac{1}{340}$ in.).

Amongst the other known species there is one, namely, *Brachionus leydigii* of Cohn, which bears considerable resemblance to *B. quadratus* and the var. *rotundus*, and there can be no doubt that the three are closely allied and belong to the same group.

B. leydigii has a square-shaped lorica like *B. quadratus*, and a rounded median spine over the foot-opening like that of the var. *rotundus*, while the lace-like structure of the lorica and the papillose winter egg it has in common with both.

However, the strongly tessellated dorsal surface of *B. leydigii*, showing five rows of hexagons and pentagons, resembling in prominence the facets of *Anuraea serrulata*, is a character which is absent in the other two forms. Bilfinger mentions having observed among his *B. quadratus* one specimen with faceted lorica, resembling Cohn's figure; and the fact of the identical structure of the resting egg in all three forms is strong evidence in favour of their being closely allied species. The resting eggs in particular usually give the best characters to differentiate closely allied species of *Brachionus*, as Cohn himself has mentioned in his memoir of 1862.

It is quite possible, therefore, that these three forms may eventually be found to be varieties of one species, in which case *B. leydigii* would be the type species and the other two varieties. However, before making such changes I should like to have the opportunity of examining some faceted specimens corresponding to Cohn's figure. My present object is merely to record the rounded variety of this group of *Brachionus*.

Brachionus rubens, Ehrenberg.

It is unfortunate that in Hudson and Gosse's monograph *B. rubens* is wrongly figured, a fact which has caused considerable confusion and difficulty in separating this species from *Br. urceolaris*. A glance at Ehrenberg's figures of *B. rubens* published in 1838 will show that the frontal teeth of the lorica have a peculiar unsymmetric shape, each tooth showing a narrow anterior part, and then slanting outwards and forming a broad base (best understood by referring to Fig. 9), quite unlike those shown in

Mr. Gosse's figures, which really represent slight varieties of *B. urceolaris*.

The lorica of both species is smooth, glassy transparent, rounded dorsally, and of about the same size. Anatomically, also, the two species can hardly be separated, and the foot-opening in both is rounded in the ventral plate and square dorsally.

The shape of the frontal teeth of the lorica therefore is the main distinguishing mark; but in addition *B. rubens* has a unique habit, mentioned by Ehrenberg as having been observed already by Schäffer in 1755, of attaching itself by its toes to water-fleas, sometimes covering the whole surface of the shell of this crustacean, and thus causing poor *Daphnia* considerable impediment and discomfort. The *Brachioni* readily detach themselves when so disposed, swim about in the water for a while and fix themselves again on the back of the next water-flea they come across. They appear quite at home there, lay numerous eggs, and breed freely. In ponds where *Daphnia* is not numerous every one of them has its load of *B. rubens* when present. If the *Daphnia* be killed, all the *Brachioni* speedily abandon the dead host. One can imagine a *Daphnia's* delight when, in moulting, which may occur once in three or four days, it can slip out of its "old clothes" and suddenly escape from its unbidden guests. It is hardly a case of symbiosis, for the advantages are all on one side.

An interesting biological problem is presented by the fact that *B. rubens* has learned to make systematic use of *Daphnia pulex* as a means of easy locomotion, whilst the closely allied species *B. urceolaris*, living in identical surroundings, has not yet acquired this useful habit. It seems clear that there must exist a corresponding difference in the intellect or in the quality of the brain of these two species which has enabled the one to discover and make use of a means of locomotion which the other has not yet thought of, and seems incapable even of imitating. The

exploitation of the obvious advantage of riding, free of charge and without exertion, on a *Daphnia's* back appears to show a higher education and greater intelligence in *B. rubens* (or perhaps a lower type of morality as suggested by Mr. Scourfield) than in *B. urceolaris.* Various free-swimming *Rotifers* occasionally and temporarily attach themselves to water-fleas; but I know of only one species other than *B. rubens* that does so systematically, namely, *Proales daphnicola*, Thompson.

Brachionus rubens is not a very common species. I have found it occasionally around London, particularly in a pond at Totteridge, and have had it sent to me from Kent and other parts in the country, always associated with *Daphnia.*

Both Dr. Hudson and Mr. Gosse appear never to have become acquainted witht he true *B. rubens.* I once showed Dr. Hudson some mounted specimens and pointed out their agreement with Ehrenberg's drawings, and their disagreement from Mr. Gosse's figures. His reply was that the only explanation he could give was that the published figures had been selected by Mr. Gosse from numerous sketches in his possession as the ones coming nearest to those of Ehrenberg; he quite agreed that Ehrenberg was correct and that his figures of *B. rubens* ought to be taken as representing the true species.

From what has been said it follows that in Hudson and Gosse's monograph, fig. 5, pl. xxvii., and also the figures of Plate A, must be taken to represent *B. urceolaris* and not *B. rubens.*

Fig. 9 of Pl. 12 has been very carefully drawn to show the usual shape of the frontal teeth of the true *Brachionus rubens*, but these teeth are subject to individual variation. Fig. 10 is a drawing from a photograph by Mr. W. Imboden of a mounted specimen under dark-ground illumination, whilst Fig. 11 represents the male drawn by Mr. F. R. Dixon-Nuttall. The resting egg is of a light brown colour, elongate, broad at one end and obtusely pointed at the other, enclosing a nearly spherical

embryo; the stout eggshell is finely granular and pitted with shallow depressions.

The measurements of this species show the following dimensions: lorica, 279 μ ($\frac{1}{91}$ in.); male, fully extended, 136 μ ($\frac{1}{185}$ in.); female egg, 122 μ ($\frac{1}{210}$ in.); male egg, 85 μ ($\frac{1}{300}$ in.); resting egg, 163 μ ($\frac{1}{155}$ in.).

Explanation of Plates.

Plate 11.

Fig. 1. *Brachionus sericus*, normal type, side view, × 160.
" 2. " " variety with pointed posterior prolongation, dorsal view, × 160.
" 3. " " variety with pointed posterior prolongation, side view, × 160.
" 4. " " male, × 390.
" 5. " " resting egg, × 200.

Plate 12.

Fig. 6. *Brachionus quadratus*, var. *rotundus*, × 180.
" 7. " " " " male, × 375.
" 8. " " " " resting egg, × 240.
" 9. *Brachionus rubens*, Ehrenbg., outline of lorica, × 200.
" 10. " " " photo, × 136.
" 11. " " " male, × 370.

NOTES ON PSEUDOSCORPIONS, BRITISH AND FOREIGN.

By Edv. Ellingsen, Kragerö (Norway).

(*Read October 18th*, 1907.)

Mr. H. Wallis Kew, of Bromley, Kent, had the kindness, last year, to send me a splendid collection of mostly British, partly determined Pseudoscorpions for further examination; and this examination, together with valuable remarks and particulars furnished by Mr. Wallis Kew, have added several very interesting facts to the knowledge of these animals. One of the most interesting facts is that *Obisium* (*Roncus*) *Cambridgii*, L. Koch, really belongs to a genus other than that to which all authors up to the present have referred it. It should enter the genus *Ideobisium* (*Ideoroncus*), Balzan, the species having indeed a galea, the true name being thus—*Ideobisium* (*Ideoroncus*) *Cambridgii*. The Rev. O. P. Cambridge, who possesses the type of this species, has been so kind as to examine this type and other British specimens, and he communicates in a letter to Mr. Wallis Kew that he can see the galea.

Mr. Wallis Kew has further been so kind as to examine Leach's types of Pseudoscorpions in the British Museum, and among the results of this examination may be noted that *Chelifer Hermanni*, Leach, is nothing but a somewhat young ♂ specimen of *Chelifer cancroides*, Linné, Leach's species thus dropping into the numerous synonyms of the latter species, as already supposed by several authors.

I here desire to offer Mr. Wallis Kew my thanks for the opportunity he has given me of studying this fine collection of Pseudoscorpions.

Chelifer Chyzeri, Tömösváry.

England: Burnham Beeches (Buckinghamshire), October, 1905. Mr. Wallis Kew took two examples under the bark of a beech-stump in company with *C. cimicoides*. I have seen one ♂.

Chelifer nodosus, Schrank.

England: South Norwood (London), August, 1906, taken by Mr. H. Hill on a fly's leg in a house; two specimens, ♂ and ♀. Louth (Lincolnshire), August, 1906, taken on a fly's leg in a grocer's shop by Mr. J. Larder; one ♀.

This species and the foregoing have great affinity to each other, but they may be distinguished by the following particulars:

Chelifer Chyzeri. Cephalothorax granulated, abdomen rather coarsely shagreened; the protuberances of the trochanter placed on the outer edges, both of them thus showing backwards; the lower protuberance very distinct (in ♂ both protuberances are somewhat pointed, in ♀ the upper is rounded); tibia and hand more granulated, the fingers proportionally a little longer and the stalk of the tibia somewhat longer than in *C. nodosus.*

Chelifer nodosus. Cephalothorax smooth and glossy, the surface behind the transverse groove may, however, be slightly granulated, though not so strongly as in the other species. Abdomen very minutely shagreened. Trochanter with the hinder protuberance very little pronounced, the upper protuberance placed distinctly on the upper surface (rounded in ♀). Tibia and hand, particularly above and below, smooth and shining.

The former species seems to be found always out-of-doors, while the latter is at least often found in houses, and often fixed to the legs of flies.

Chelifer cyrneus, L. Koch.

I have seen one ♀ from Sherwood Forest (Nottinghamshire).

Chelifer cimicoides, Fabr.

I have seen specimens from Burnham Beeches (Buckinghamshire).

Chelifer dubius, Cambridge.

? 1837. *Chelifer Schrankii*, C. L. Koch, *Dtschl. Crust., Myr. u. Arachn.*, h. 7, n. 3, t. 3.

1892. *Chernes dubius*, Cambridge, *Brit. False-Scorp.*, p. 227, pl. C, f. 19.

1899. *Chelifer*, n.sp. ? Tullgren, *Bidr. t. känned. Sveriges Pseudosc.*, p. 176, tafl. I, f. 11–12.
1900. *Chelifer Tullgreni*, Strand, *Arachnologisches*, p. 102.

No eyes, nor ocular spots.

Colour. Cephalothorax, sclerites, and legs greyish brown, palps pale reddish brown, the interstitial parts greyish white.

Cephalothorax about as long as broad behind, regularly narrowing forwards, the front margin rounded. The anterior transverse groove about in the middle, indistinct and slightly concave (*i.e.* slightly curved backwards); the posterior groove nearly invisible (most visible when the animal is in a dry state), a little nearer to the hinder margin than to the first groove. The surface a little glossy, minutely granulated; along the lateral margins the granules are slightly prominent. The hairs moderately long, slightly clavate or only obtuse and dentated.

Abdomen. The tergites nearly devoid of gloss, slightly granulated, divided longitudinally except the last one; the two anterior tergites very short, the rest longer and of nearly equal length. The hairs along the hinder margins rather long, slightly yet distinctly clavate. The sternites somewhat glossy, finely striped transversally, divided longitudinally except the last one; the hairs along the hinder margins rather long, pointed; on the last somite two long, pointed "tactile hairs."

Palps about as long as the body with the abdomen extended, moderately robust. Coxa somewhat glossy, with scattered granules and pointed hairs. The other joints somewhat glossy, distinctly granulated, particularly on the inner side of femur and tibia, where the granules are very much pronounced; the lower surface of the hand is nearly and the fingers quite smooth. The hairs of the inner side of the palps are slightly clavate, those of the outer side and of the hand only dentated, of the fingers pointed; the hairs are densely set, particularly on the outer side of tibia and hand. Trochanter with a rather long stalk, and, apart from this, a little longer than wide; the outer side with a small, rounded knob in the middle; the upper surface with a strong, rounded prominence next to the extremity. Femur rather slender, with a long stalk, the inner side proximally slightly convex, in the distal part distinctly concave, behind obliquely widened from the stalk, the outer margin slightly and evenly convex; the femur is somewhat

curved forwards and nearly parallel-sided, not attenuated towards the extremity. Tibia with a rather long stalk, a little shorter and a little broader than femur, moderately robust, the outer side evenly and moderately convex, in front considerably widened from the stalk and strongly convex in the proximal part, in the distal part nearly straight; the tibia is only slightly narrowed towards the extremity. Hand with a short stalk, with obliquely rounded base, about as long as and considerably broader than tibia, the outer side moderately and evenly convex, the inner side somewhat more strongly so, on both sides passing evenly and gradually into the fingers. Fingers moderately robust, somewhat curved, a little longer than the hand or of equal length, not gaping; some "accessory teeth" are present.

Mandibles. Galea of somewhat varying shape, in ♀ a little more robust than in ♂, differing little in form in the two sexes; it is generally divided at the extremity and provided with some teeth along the inner side, but there may be a couple of teeth only at the middle of the inner side.

Legs. The outer side with clavate hairs; on the inner side the hairs are dentated and pointed. The femora of the two posterior pairs of legs rather narrow, not much broader than those of the two anterior pairs. Claws simple.

Sexual area of the ♂ of *cimicoides* type.

Length of the largest specimen, 1·92 mm.

Measurements. Cephalothorax: long. 0·56; lat. behind 0·50. Femur: long. 0·47; lat. 0·16. Tibia: long. 0·43; lat. 0·20. Hand: long. 0·43; lat. 0·27. Fingers: long. 0·47 mm.

This species has apparently a wide distribution in England and Scotland. The types were found at Glanville's Wootton and Sherborne (Dorsetshire). Later it was found by the Rev. R. Godfrey in Scotland. I have seen specimens from Cudham and Walmer (Kent), collected by Mr. Wallis Kew, under embedded stones on wooded hill-sides, and from Crail (Fifeshire), taken by the Rev. R. Godfrey under stones; in Fifeshire it was plentiful along the coast. Scottish specimens were inspected in 1902 by Mr. Tullgren, of Stockholm, who recognised them as his Chelifer n.sp.? of 1899.

Thanks to the Rev. O. P. Cambridge's kindness, I have been able to compare the specimens with the type from Glanville's Wootton.

Chelifer scorpioides, Hermann.

1897. *Chernes minutus*, Ellingsen, *Norske Pseudoscorpioner*, p. 12.

England. I have seen specimens taken by Mr. F. W. Wilson at Roydon (Essex) and at Beckenham (Kent), in both localities in a rubbish heap. I have also examined a specimen from Weybridge (Surrey); Mr. H. Donisthorpe took at the latter locality several specimens from a nest of *Formica rufa.*

The study of a great number of specimens, males and females, from Italy (collected at Rome by Mr. Adolfo Rossi, who has liberally sent them to me for examination) has convinced me that the new species which I described in 1897 as *Chernes minutus* is only the male of *C. scorpioides*, Hermann, such as this species was established by Tömösváry; whether it is that of earlier authors will be more difficult to decide. But Tömösváry certainly had only female specimens before him, with stagshorn-like galea, while the males have the galea more simple, with a couple of teeth on the outer side, this being the reason why I did not identify *C. minutus* with *C. scorpioides.*

Chelifer Panzeri, C. L. Koch.

?1837. *Chelifer Panzeri*, C. L. Koch, *Dtschl. Crust., Myr. u. Arachn.* h. 7, n. 6, t. 6.
?1843. *Chelifer Panzeri*, C. L. Koch, *Die Arachniden.* x. p. 44, f. 782, 783.
1879. *Chelifer rufeolus*, E. Simon, *Arachn. de France*, vii. p. 41, pl. xviii. f. 15.
1905. *Chernes rufeolus*, E. Simon, Cambridge, *Proc. Dorset. Field. Club*, xxvi. p. 56, pl. B, f. 29, 30.

No eyes, nor ocular spots.

Colour. Sclerites and cephalothorax brown (the anterior part of cephalothorax sometimes darker than the posterior half); palps dark reddish brown, the interstitial parts and legs greyish white.

Cephalothorax a little longer than wide, behind the anterior groove nearly parallel-sided, before the groove evenly rounded. Two distinct, rather broad transverse grooves, of which the anterior one is about in the middle, turning forwards laterally;

above nearly straight, in the middle, however, curving slightly forwards; the posterior groove considerably nearer to the hinder margin than to the first groove, and nearly straight. The surface a little glossy or nearly dull, distinctly and evenly granulated, with short, clavate hairs.

Abdomen. Tergites slightly glossy, distinctly granulated, all divided longitudinally, except the last one, and having along the margin of each tergite a dense row of moderately long, decidedly clavate hairs inclining backwards; on the last somite two pairs of "tactile hairs." Sternites somewhat glossy, granulated, distinctly divided longitudinally except the last one; the hinder margins with pointed hairs.

Palps about as long as the body, partly without gloss. Coxa smooth and glossy, with pointed hairs. The other joints (except the fingers) are finely granulated, the granulation, especially on the tibia and hand, being much obscured and rather roughened. The hairs are more or less distinctly clavate, more especially so on the inner side of the proximal joints, less distinctly on the outer surface and on the hand; the fingers have pointed hairs. Trochanter with a rather long stalk; apart from this little longer than wide, the inner side strongly convex, behind with a rounded prominence near the base, above with a similar one nearer to the extremity. Femur with a distinct stalk; apart from this about twice as long as broad; seen from above it is, in front, in the proximal part slightly convex, distally slightly concave, behind a little widened from the stalk, the outer margin very little convex, the whole narrowing but little towards the extremity; laterally seen, it rises almost perpendicularly and very strongly from the stalk, the upper surface being very convex, the lower side flattened. Tibia with moderately long and robust stalk, the outer side evenly and rather strongly convex, in front rather abruptly widened from the stalk, in the proximal half somewhat swollen, distally slightly concave. Hand with a short stalk, the base, seen from above, somewhat obliquely rounded, the outer side moderately convex, the inner side more strongly so, gradually passing into the fingers; laterally seen, though somewhat obliquely, the base makes almost a right angle with the stalk, the hand being higher than broad; the hand is not quite twice as broad as tibia, as E. Simon states it to be for his *C. rufeolus*, only a little more than one-and-a-half times as broad, if the

greatest oblique height is taken as the width. Fingers moderately robust, somewhat curved, a little longer than the hand, slightly gaping, more so in ♂, less in ♀, both fingers provided with some large and small "accessory teeth" on the inner side in the distal half.

Mandibles. Galea nearly of the same shape in both sexes, moderately robust, pointed, with teeth of different length along the underside.

Legs. The outer side with clavate, the inner side with pointed hairs. The tarsus of the IV. pair provided, in undamaged specimens, with a short "tactile hair" somewhat nearer to the middle than to the extremity. Coxa IV. in ♂ narrow, nearly triangular, wider distally, the inner-posterior corner being very much rounded; in ♀ coxa IV. is much broader and larger, nearly parallel-sided, with the inner corner only slightly rounded; no coxal sac. Claws simple.

Sexual area of ♂ of *cimicoides* type.

The whole palp seems stronger and more robust in ♂ than in ♀, and in particular the hand of ♂ is higher and altogether more voluminous than hand of ♀.

Length, ♂, 2·43 mm., width, 0·90 mm. Length, ♀, 2·86 mm.

Measurements, ♂. Cephalothorax: long. 0·79; lat. 0·69. Femur: long. 0·63; lat. 0·29. Tibia: long. 0·50; lat. 0·31. Hand: long. 0·50; lat. 0·45; alt. 0·49. Fingers: long. 0·64 mm.

The description is based on two specimens, ♂ and ♀, taken by Mr. H. Wallis Kew near Deal (Kent), under bricks on the floor of a disused cottage in which fowls and rabbits had been kept, and seven examples, two ♂ and five ♀, taken by Mr. H. E. Freeman at Chisledon (Wiltshire), among refuse in horse-stables. Mr. H. Wallis Kew communicates to me that the same species has also been collected by himself at West Wickham (Kent), among débris at the foot of an old elm near a farm, and at Hogsthorpe (Lincolnshire) among débris in a stable; further, he has seen it from Belper (Derbyshire), among refuse in a loft over a stable, and from Dagenham (Essex) among refuse in farm-buildings. It is thus seen that the specimens, with a single exception, have been taken in buildings.

It is with some doubt that I have ventured to refer these specimens to C. L. Koch's *Chelifer Panzeri*, and to re-establish

this species which both L. Koch and E. Simon have dropped into the synonyms of *C. cimicoides*, Fabr., or at most regarded as a variety of the latter species. But it may happen that C. L. Koch indeed had before him some examples of the same species as the English specimens. The identity of the habitat may strengthen this. C. L. Koch said, indeed, about his specimens, that they had been found "in Pferdeställen"—"in altem Heu." One thing is certain, the English specimens are quite different from *C. cimicoides*, and it would be impossible to regard them as a variety of this species. Mr. E. Simon has had examples of the species, and has referred them to *C. rufeolus*.

Chelifer Wideri, C. L. Koch.

Mr. H. Wallis Kew has collected this species at West Wickham (Kent), one ♂, two ♀, under bark of an old oak-tree, and at Edwinstowe (Nottinghamshire), a young female under similar circumstances.

I have compared these with specimens from Finkenberg, near Berlin, and can find no essential differences. The English ♀ specimens have the inner side of the tibia of the palps passing more gradually from the stalk, the German ones a little more abruptly so; but the single English ♂ I have seen is, in this respect, quite like the German.

Chelifer cancroides, L.

England: Polegate (Sussex), obtained by Mr. C. H. Caffyn, from fig-refuse in a confectioner's factory; two specimens ♂ and ♀.

Chelifer Kewi, nov. sp.

Two distinct eyes, one on each side.

The body broadly oviform.

Colour. The whole animal of a uniform dark brown, except the interstitial parts and the legs, these being somewhat lighter.

Cephalothorax about as long as broad behind, gradually narrowing forwards, the lateral margins nearly straight, the

front margin almost straight also; two distinct, deep, straight, transverse grooves, the anterior one about in the middle, the posterior groove a little nearer to the hinder margin than to the first. The surface coarsely and evenly granulated, laterally with some larger granules, with short, pale, clavate hairs.

Abdomen. Tergites generally divided longitudinally, even the last one, but the division may often be somewhat indistinct; the surface distinctly granulated, the sclerites provided along the hinder margins with short, strong, decidedly clavate hairs, inclining backwards; no "tactile hairs" on the last somite. Sternites (except the sexual one) divided longitudinally, the surface minutely granulated or nearly shagreened; along the margins are rows of distinctly clavate hairs.

Palps about as long as the body, moderately robust, distinctly granulated and without gloss (coxa included), except the fingers; femur and tibia, besides the common granulation, are provided with some scattered, larger granules, especially on the inner side. The hairs of the proximal joints are somewhat clavate, distally the hairs become only obtuse; the fingers have pointed hairs. Trochanter with a rather long stalk, subglobose, the inner side strongly convex, the outer and upper sides each with a rather strong prominence. Femur with a short, but distinct stalk, the inner side nearly straight, a little sinuated, however, near the extremity, behind rounded at the base and at the extremity, the outer margin nearly straight or very slightly convex; femur altogether nearly parallel-sided, seen laterally somewhat curved upwards. Tibia with a short, but robust stalk, shorter than femur, somewhat oblique and gradually widening from the stalk, somewhat rounded at the extremity, the inner side rather strongly convex in the proximal half, the outer margin (the rounding of the stalk excepted) nearly straight in the greater proximal part, distinctly convex towards the extremity. Hand with a distinct stalk, about as long as and much broader than tibia, with obliquely rounded base, the outer side slightly convex, the inner side considerably more strongly so, passing somewhat abruptly into the fingers. Fingers robust, somewhat curved, in ♂ about as long as the hand and somewhat gaping, in ♀ a little shorter than the hand.

Mandibles. Galea in ♂ very small, with no teeth; in ♀

considerably stronger, divided in the extremity to form some fine teeth.

Legs uniformly granulated, even the coxae; the outer side of the legs with short, clavate hairs, the inner side with obtuse hairs; no "tactile hairs." The coxae of the fourth pair in ♂ very narrow and curved.

Coxal sac present. The tibia of the first pair in ♂ has the inner side widened and in the same sex the outer claw of the first pair is angularly curved instead of being curved in the usual manner. The claws have no inner teeth; they seem to be of larger size compared with those of the ♀. The coxae of the fourth pair in ♀ are very broad, somewhat projecting behind the trochanter, where the coxa forms a produced right angle.

As to the shape of the first pair of legs in ♂, this species resembles *C. disjunctus*, L. Koch, and *Ch. peculiaris*, L. Koch, as well as *C. Latreillii*, Leach, but it differs from these species by the clavate hairs on the lower side of abdomen.

Sexual area in ♂ is of *C. cancroides* type, but differs somewhat, however, from that species; the sexual opening lies very near the posterior coxae. The two sternites behind the posterior sexual plate have a narrow, transverse, dark stripe on each sclerite.

Length. ♂ 2·15 mm., with contracted abdomen.

Measurements. ♂, Cephalothorax: long. 0·72; lat. behind, 0·79. Femur: long. 0·72; lat. 0·24. Tibia: long. 0·61; lat. 0 29. Hand: long. 0·64; lat. 0·40. Fingers: long. 0·64 mm.

Habitat. Africa, Cape Colony: Witte Hardt, Nieuwveldt, about 5,000 ft. above the sea, collected by the late Mr. T. M. Kew, in March, 1905, under pieces of stone on sandy ground.

Note. I have seen two males and two females. The species has some affinity with *C. Sauteri*, Ell., from Japan, but is larger, and has the coxae of the fourth pair of legs in ♂ still more slender.

Chelifer Latreillii, Leach.

1817. *Chelifer Latreillii*, Leach, *Zool. Misc.* 3, p. 49, pl. 142, fig. 5.
1837. „ *Degeeri*, C. L. Koch, *Dtschl. Crust. Myr. u. Arachn.* 2, t. 3.
1837. „ *angustus*, C. L. Koch, *Ibid.* 7, n. 5, t. 5.

1839. *Chelifer Schaefferi*, C. L. Koch, *Uebers. Arachn.*, 2 H., p. 4.
1843. „ *Degeeri*, C L. Koch, *Die Arachniden.* x., p. 53, f. 788, 789.
1843. „ *Schaefferi*, C. L. Koch, *Ibid.* x., p. 55, f. 790.
1845. „ *pediculoides*, Lucas, *Arachn. etc. de l'Algérie*, p. 275, pl. xviii., f. 6 (sec. E. Simon).
1873. „ *Schäfferi*, C. L. Koch, L. Koch, *Uebers. Darst. europ. Chernet.*, p. 17.
1874. „ *brevipalpis*, Canestrini, *Osserv. aracn. fauna. ital.* (sec. Canestrini).
1874. „ *Ninnii*, Canestrini, *Ibid.* (sec. Canestrini).
1875. „ *Schäfferi*, C. L. Koch, Stecker, *Kennt. Chernet. Böhmens*, p. 12.
1879. „ *Degeeri*, C. L. Koch, E. Simon, *Arachn. de France*, vii., p. 22, pl. xviii., f. 4.
1882. „ *Degeeri*, C. L. Koch, Tömösváry, *Pseudosc. faun. Hung.*, p. 204, pl. ii., f. 10–11.
1883. „ *Degeerii*, C. L. Koch, Canestrini, *Chernet. italici*, fasc. vii., n. 2, t. 2.
1884. „ *Schaefferi*, C. L. Koch, Hansen, *Arthrogastra Danica*, p. 541.
1892. „ *Latreilli*, Leach, Cambridge, *On Brit. False-Scorp.*, p. 223, pl. B., f. 13.
1899. „ *Schäfferi*, C. L. Koch, Tullgren, *Bidr. Känned. Sveriges pseudosc.*, p. 169, pl. 6, f. 2–5.

The descriptions, previously given of this beautiful species or of its synonyms, may be supplemented thus:

Colour. The clear reddish fingers, and the reddish extremities of femur and tibia of the palps are characteristic of this species, as also indicated by L. Koch in *C. Schäfferi*, thus strengthening the identity of these two species; to this may be added the strongly curved fingers.

The tergites of the ♂ are not cavinated laterally, as they are in *C. cancroides.* The upper side of the trochanter of the palps is, in the extremity, produced into a small brown point, visible only when viewed laterally.

Mandibles. Galea in ♂ small, certainly never with any teeth, in ♀ considerably more robust, with several teeth at the point.

The sexual area of the ♂ proves that the species belongs to the *cancroides* group; the coxae of the fourth pair of legs strongly curved.

In ♂, the claws of the first pair of legs are very little curved, much straightened; the exterior claw, along nearly the whole inner margin, may be provided with a great number of small, pointed teeth; in some specimens only the central part has these teeth; which, according to Mr. Wallis Kew, are sometimes very indistinct. The first leg in ♂ is altogether of greater strength than that of ♀, the tibia more tumid, as also is the tarsus, and the claws are larger. Coxal sac present.

I have examined ten specimens, five of each sex, from England: Lincolnshire, where Mr. Wallis Kew has found the species plentifully on the sand dunes of the coast, over an area of nearly thirty miles. Mr. Wallis Kew has examined the type in the British Museum.

There is certainly no doubt that the above list of synonyms is correct; in other words, that *C. Schäfferi* and *C. Degeeri* are synonymous with *C. Latreillii*, the species thus having a vast distribution.

Cheiridium ferum, E. Simon.

1879. *Chiridium ferum*, E. Simon, *Arachn. de France*, vii., p. 44, pl. xviii., f. 21.

E. Simon's description of this species may be supplemented thus:

Two eyes, more or less distinct. All eleven tergites are visible from above; the last, or the last two, are entire, the rest divided longitudinally by a fine stripe. The movable finger of the mandibles is somewhat truncated in the extremity; in ♀ the galea consists of three stemlets, simple and arranged in a row; in ♂ the galea is smaller, and consists of but a single stemlet. There is but little difference between the sexes, except in the sexual area; the ♂ appears to be somewhat smaller than the ♀.

Length. ♂, 1·10 mm.; ♀, 1·22 mm. long; 0·64 mm. wide.

Measurements. ♀. Cephalothorax: long. 0·39; lat. behind 0·44. Femur: long. 0·34 (with the stalk), 0·31 (without the

stalk); lat. 0·07. Tibia: long. 0·23; lat. 0·10. Hand: long. 0·20; lat. 0·13. Fingers: long. 0·21 mm.

I have examined six specimens, three of each sex, from France, near St. Servan (Ille-et-Vilaine), where the Rev. R. Godfrey has taken it in great numbers under bark of pine-trees. The species has previously been found only at Arcachon (Gironde) by E. Simon. I have also seen a specimen from Central Italy collected by Mr. Adolfo Rossi.

This species differs considerably from *C. museorum*, Leach, but has much more affinity with the South American species *C. corticum*, Balzan, from which it may, however, be distinguished without difficulty among other characters by the more robust tibia. In the South American species too the eleventh tergite is visible from above to a degree, though not quite so distinctly as in the French species. *C. museorum*, Leach, has only ten tergites visible from above; in this species the galea of the ♂ is small and acute, and in the ♀ it consists of only one stemlet, stronger than that of the ♂, and with some small teeth in the point.

Cheiridium museorum, Leach.

I have seen specimens taken by Mr. Wallis Kew at Rainham (Essex) under the wall-paper of a deserted cottage.

Ideobisium Cambridgii, L. Koch.

1873. *Roncus Cambridgii*, L. Koch, *Uebers. Darst. europ. Chernet.*, p. 45.

?1879. *Obisium lubricum*, L. Koch, E. Simon, *Arachn. de France*, vii., p. 63, pl. xviii., f. 22.

1892. *Roncus Cambridgii*, L. Koch, Cambridge, *Brit. Sp. False-Scorp.*, p. 217, pl. B. f. 9.

Two small eyes, one on each side, more than two diameters from the front margin.

Colour. Cephalothorax and palps light reddish brown, sclerites light brownish, the interstitial parts and the legs greyish white.

Cephalothorax about as long as wide, parallel-sided up to the eyes, before these a little contracted, the front margin slightly convex, not depressed in the middle. The surface glossy and completely smooth. Hairs pointed.

Abdomen. Tergites and sternites glossy, very minutely shagreened, the anterior tergites somewhat more distinctly so. Along the hinder margins are pointed hairs, on the last somite "tactile hairs."

Palps about as long as the body when the abdomen is extended, glossy. Coxa and the lower side of trochanter smooth, the other joints (except the fingers) more or less distinctly granulated, more so on the upper and the inner side, on the adjoining part of the lower side of the femur, and on some parts of tibia and hand. The hairs pointed, densely set, and rather long. Trochanter with a very short stalk, when this is excepted considerably longer than wide, the inner side very little convex, the outer side nearly straight, with a very small prominence about in the middle. Femur with a distinct stalk, rather robust, the stalk included about three times as long as wide, the inner side nearly straight from the beginning of the stalk to the extremity or slightly convex in the middle, behind obliquely widened from the stalk, the outer margin nearly straight or even a little concave in the middle; femur for the greater part nearly parallel-sided and not attenuated towards the extremity. Tibia with a rather long stalk, apart from this broadly and somewhat obliquely oblong, the outer side somewhat flattened from the beginning of the stalk for a distance, the distal part a little convex, on the inner side rather abruptly widened from the stalk, the inner margin proper rather strongly convex; tibia in all but little narrowing towards the extremity. Hand with a proportionally long stalk, with obliquely rounded base, somewhat elongate, the outer side very little convex, the inner much more so, and there passing rather abruptly into the fingers. Fingers robust, only slightly curved, about as long as the hand, on the inner margins with many small teeth, closely set.

Mandibles. Galea equal in both sexes, small, at the point divided into two to three fine teeth.

Legs with pointed hairs, the femora of the two posterior pairs not very broad. The outer corner of the coxa of the first pair with a strong, dark point. The coxae of the fourth pair nearly alike in both sexes, broad, set closely together. Claws simple.

There is no essential difference between the sexes, except the sexual area; the single ♂ I have seen is considerably smaller

than the largest ♀, but the abdomen of this ♂ was much contracted.

A very young specimen was easily recognised as belonging to this species, and had the galea similar to that of the full-grown ones.

Length, ♀, 2·35 mm.; width, 0·79 mm. Length, ♂, 1·57 mm.

Measurements. ♀. Cephalothorax: long. 0·56; lat. 0·53. Femur: long. 0·57; lat. 0·20. Tibia: long. (with stalk) 0·50, (without stalk) 0·36; lat. 0·24. Hand: long. 0·50; lat. 0·33. Fingers: long. 0·46 mm.

I have seen six specimens, one ♂ and four ♀, and a young one from Scotland—Oban (Argyllshire)—taken by the Rev. R. Godfrey.

The Rev. O. P. Cambridge, as mentioned in the introduction, has re-examined L. Koch's type of this species and has found the galea. L. Koch evidently examined the animal with too small a magnification. The Scottish animals agree well with L. Koch's description, except that the femur is stated to be granulated only on the inner and the lower side, while the Scottish specimens are quite as strongly granulated on the upper side of the femur.

Obisium lubricum, L. Koch.

I have examined one specimen from Greenwich (Kent), taken by Mr. F. W. Wilson.

Obisium maritimum, Leach.

1817. *Obisium maritimum*, Leach, *Zool. Misc.*, 3, p. 52, pl. 141, f. 1.
1872. „ „ Leach, Grube, *Mitth. ü. St. Malo u. Roscoff*, p. 119, Taf. I, f. 2.
1889. „ *littorale* Moniez, *Sur un Pseudo-Scorpion marin*, *Rev. biol. du Nord d. France*, p. 104.
1892. „ *maritimum*, Leach, Cambridge, *On Brit. False-Scorp.*, p. 215, pl. B, f. 8.

Four large eyes, two on each side, the anterior one about a

diameter from the front, the posterior one about $\frac{1}{2}$ diameter from the first.

Colour. The tergites, sternites, and cephalothorax olivaceous brown, the last with a darker band along the hinder margin; mandibles and palps reddish brown; legs light greyish.

Cephalothorax as long as wide, parallel-sided, before the eyes a little contracted; the front margin from the middle somewhat oblique, and in the middle provided with a rather large, obtuse tooth. The surface glossy and completely smooth, provided with pointed hairs.

Abdomen. Tergites and sternites smooth and glossy, each along the hinder margin with a dense row of pointed, rather long hairs, increasing in length backwards; the last somite with "tactile hairs."

Palps about as long as the body (with abdomen extended), glossy and smooth, except the hand, which has in the distal half very minute and low granules. The hairs are long and pointed, on the inner side, especially of the femur, a little longer than on the outer side. Trochanter with a very short stalk, a little longer than wide, the inner side nearly straight, only a little rounded at the base, behind nearly straight with a very small prominence in the middle. Femur with no distinct stalk, club-shaped, that is, gradually widening to the extremity, but only very slightly so, the inner and the outer margins nearly straight; there is, however, a slight tendency to a curving forwards in the middle; laterally seen the femur is slightly curved upwards. Tibia with a distinct, robust stalk, this excluded but slightly more than one half as long as the femur and only a little wider, behind moderately and evenly convex from the beginning of the stalk to the extremity, the inner side gradually widened from the stalk and rather strongly convex; the membrane reaches $\frac{1}{3}$ backwards (the stalk excluded). Hand with a short stalk, the base much rounded, very narrow, nearly twice as long as wide, the outer side nearly flat, the inner side a little convex. Fingers robust, slightly curved, somewhat shorter than the hand, a little gaping, the inner margins densely set with small, pointed teeth, all of the same height; the fingers are in the vertical plane only slightly at angles with the hand.

Mandibles large, nearly smooth; the movable finger distinctly thickened at the distal curve.

Legs. The outer corner of the coxa of the I. pair with a long, brown protuberance; the inner corner with a small, but distinct, light point. The femora of the two posterior pairs of legs moderately broad. Claws simple.

Length of the largest specimen 2·50 mm., breadth 1·13 mm.

Measurements. Cephalothorax: long. 0·76; lat. 0·74. Mandibles: long. 0·50. Femur: long. 0·93; lat. 0·24 at the extremity. Tibia: long. 0·57 (stalk excluded 0·46); lat. 0·27. Hand: long. 0·76; lat. 0·40. Fingers: long. 0·67 mm.

The above description is based on two specimens from Port Erin (Isle of Man), taken by Dr. A. R. Jackson, in rock-crevices below high-water mark. I have also seen a specimen from St. Ives (Cornwall), collected by Mr. F. W. Wilson, and one from Scotland, at the head of Loch Fyne, near Shirvan (Argyllshire), taken by the Rev. R. Godfrey, in both cases under embedded stones below high-water mark.

I have no doubt that the specimens taken in France by Grube at St. Malo and by Moniez near Boulogne, the latter specimens published by Moniez under the name *Obisium littorale*, n.sp., must be referred to this species.

This interesting and, till now, little known species very much resembles, by its slender hand, *Obisium validum*, L. Koch, from Syria, but the latter has no tooth on the inner corner of the coxa of the I. pair of legs, the tibia of the palps not convex on the inner side, cephalothorax longer than wide.

Obisium muscorum, Leach.

This species is widely distributed in England and Scotland, as well as on the Continent, where it has been found from north of the polar circle in Norway to the Mediterranean. Mr. Wallis Kew sent me specimens from Kent, Essex, Buckinghamshire, Ayrshire, Midlothian, Argyllshire, and Ross-shire; further from Snowdon (Wales), at about 3,500 ft., in the last locality taken by Dr. A. R. Jackson.

Chthonius tetrachelatus, Preyssler.

England: Deal (Kent), collected by Mr. Wallis Kew.

Chthonius Rayi, L. Koch.

England: East Horsley (Surrey), and Folkestone (Kent), in both localities collected by Mr. Wallis Kew.

Chthonius tenuis, L. Koch.

I have examined specimens from Hambledon and Box-hill (Surrey), taken by Mr. H. Wilson, and from Cudham (Kent), in the latter locality collected by Mr. Wallis Kew.

THREE WATER-MITES NEW TO BRITAIN.

By George P. Deeley.

Read October 18th, 1907.

Plate 13.

Thyopsis cancellata, Protz.

This mite is of a deep red colour with dark, almost black, markings.

Body a broad oval.

Length about 1·54 mm., breadth 1·33 mm.

The dorsal surface is hard, with a large number of spots more or less square in outline, and the remaining area covered with fine green markings. The effect is to cause the back to look like a perforated plate. Eyes distinct and wide apart. Edge of body when focussed with a ½-in. objective appearing as if covered with a fringe of very fine hairs. Epimera in four groups, and small in proportion to size of body. Legs—1st pair about ·7 mm. long, 4th pair 1·15 mm., all supplied with a large number of short thick spines or hairs. Colour a light red, and, together with the epimera, covered with fine green markings. Claws to all feet. Palpi thin, 0·4 mm. long, 2nd segment being thickest, furnished with several strong hairs, and a small peg on inner edge of last segment but one. Genital area composed of two plates, with three acetabula on each plate, one at forward end and two at posterior. Inner edge of both plates fringed with

hairs. The integument on the ventral side is covered with fine circular markings.

Only one specimen taken, a female.

Locality. Himley Park, Staffs.

The genus *Thyopsis* has not hitherto been recorded for Great Britain.

Sperchon glandulosus, Koen.

In *Science Gossip* for January, 1900, Mr. C. D. Soar describes two species of the genus *Sperchon* (Kramer). In May, 1903, I took another species of the same genus, namely, *Sperchon glandulosus*, not previously recorded for Great Britain.

This mite is of a pale red colour with a deeper red spot in centre of epimeral plates. The latter are in four groups, and covered with fine green markings. The skin is covered on dorsal and ventral surfaces with a number of very conspicuous dermal glands varying a little in size. In one specimen the number of glands counted was sixteen on the dorsal side and twelve on the ventral side. The rostrum extends some distance in front of the first pair of epimeral plates.

Length about 1·0 mm. Breadth 0·84 mm.

Legs supplied with a number of short hairs, but no long swimming hairs; colour pale green. Claws to all feet. Palpi about ·33 mm. long. Second segment thick, and furnished with a strong peg, close to which there is a stiff bristle. On the outer edge are four stiff bristles. The last segment but one has two fine hairs on the outer edge. Last segment has two small pegs on inner edge, with three fine hairs at extremity. Genital area composed of two plates; on the inner edge of each are three acetabula, the first two pairs being elongated, and the last pair nearly circular. The mite is not a vigorous swimmer, preferring

to crawl slowly upon the vegetation. I took nine specimens, all females, on the date above mentioned, one of which I managed to keep alive in a tube for about a month.

Lyania bipapillata, Sig Thor.

This mite is elliptical in form, flattened slightly at the posterior and anterior ends. Colour red with brown markings.

Length about 0·6 mm. Breadth 0·54 mm.

The dorsal side has a depressed line running all round the margin of the body, and is covered with fine green markings. Eyes very distinct, not very far apart. Epimera formed close together, and covering nearly the whole of the ventral surface. The posterior pair of epimeral plates are produced backwards and rounded, the whole surface being covered with fine markings. The genital plates are in two parts, formed on a depression, which appears to run round the body when viewed ventrally, very similar to that of the genus *Brachypoda.* There are three acetabula on each plate, and several small pores, and two nipper-shaped projections from the centre of the plates. Two strong teats, each terminating in a short hair, project from the depressed surface, one on either side of the genital area. Palpi thin with several long hairs, and a small peg on last segment but one. Legs sparingly supplied with short hairs—1st pair ·42 mm. long, 2nd pair ·35 mm., and 4th pair ·54 mm. Colour almost transparent.

Only one specimen taken, a female.

Locality. Himley Park, Staffs.

The genus *Lyania* has not hitherto been recorded for Great Britain.

Explanation of Plate 13.

Fig. 1*a*.	*Thyopsis cancellata* ♀,	dorsal surface.
,, 1*b*.	,, ,,	ventral ,,
,, 1*c*.	,, ,,	genital area.
,, 2*a*.	*Sperchon glandulosus* ♀,	dorsal surface.
,, 2*b*.	,, ,,	ventral ,,
,, 2*c*.	,, ,,	genital area.
,, 2*d*.	,, ,,	palpus.
,, 3*a*.	*Lyania bipapillata* ♀,	ventral surface.
,, 3*b*.	,, ,,	dorsal ,,

SOME BRITISH SPIDERS TAKEN IN 1907.

By Frank P. Smith.

(*Read November 15th*, 1907.)

Plate 14.

Judging from the experiences of workers in many branches of entomology, the year 1907 does not appear to have been by any means a prolific one. One might naturally assume, therefore, that spiders would be correspondingly scarce, and from personal experience I think we must regard the year as considerably below the average. The study of the spiders, however, has made good progress during this period, several workers having, at the expense of a great deal of hard work, added considerably to our knowledge of the group. In this connection must be specially mentioned Mr. William Falconer, of Slaithwaite, for, although the name of this gentleman has not been brought before the public to any great extent in published papers, his assiduous and conscientious collecting in the Huddersfield area has resulted not only in the discovery of many rare and interesting spiders, but has demonstrated the real identity of several obscure types whose elimination from the list will be greatly appreciated by his brother workers.

My own outdoor work has, I fear, been very limited, and impeded greatly by indifferent health. Three weeks at Hastings and three days in the Isle of Wight is the sum-total outside the London area. I am able, however, to add one species to the British list and to record localities for several others which appear to be exceedingly rare.

Family DRASSIDAE.

Gnaphosa lapidosa (Walck.), 1802.

1802. *Aranea lapidosa*, Walck., *Faune Par.*
1804. ,, *lapidicola*, Latr., *Hist. Nat. Crust. Ins.*
1805. *Clubiona lapidicolens*, Walck., *Tabl. Aran.*
1833. ,, *lapidaria*, Hahn, *Monog. Aran.*
1861. *Drassus lapidicolens*, Bl., *Sp. G. B. I.*
1879. ,, *lapidicolens*, Camb., *Spid. Dorset.*

Gnaphosa lapidosa, var. cuprea (Bl.), 1834.

1834. *Drassus cupreus*, Bl., *Researches in Zool.*
1861. ,, *cupreus*, Bl., *Sp. G. B. I.*
1881. ,, *cupreus*, Camb., *Spid. Dorset.*

Gnaphosa lapidosa, var. macer (Thor.), 1875.

1875. *Drassus macer*, Thor., *Sv. Ak. Handl.*

Typical examples of the species generally known as *Drassus lapidosus*, Walck., occurred very plentifully on the shore between St. Leonards and Bexhill. In company with these, and also at Camber, near Rye, there were forms which distinctly approached the typical *D. cupreus* of Blackwall. A comparison of both these forms with Epping Forest specimens and with the darker northern types which are generally considered to be *D. cupreus*, Bl., has convinced me that there is no really reliable character by which the two species can be differentiated. The general colouring, the epigynum of the female and the dentation of the male falces are the characters upon which reliance seems to have been placed, and all of them are, in this group, notoriously variable. The tibial apophysis of the male palpus certainly shows some trifling difference, inasmuch as in the *lapidosus* type it is, when viewed in profile, conical and straight-sided, whereas in *cupreus* it is usually wider at the base and somewhat excavated laterally. I find, however, that this distinction is unreliable, as every shade of transition seems to occur even in individuals from the same locality and apparently all of one type.

Continuing this investigation I find that *Drassus macer*, Thor., also seems to lack any distinctive character which will separate it from *D. lapidosus*, Walck., of which it appears to be merely a dwarfed form. Several Continental writers have been for some time past of this opinion, and I formerly upheld the species only as the result of an examination of the late F. Pickard-Cambridge's specimens; but a careful comparison of my drawings of these examples has clearly demonstrated that they were wrongly identified.

I propose, therefore, to specifically unite *D. cupreus*, Bl., and *D. macer*, Thor., with *D. lapidosus*, Walck., and to regard them as varieties of this species. *D. macer*, Thor., appears to be rather rare. *D. cupreus*, Bl., and *D. lapidosus*, Walck., are abundant, the former in the north and the latter in the south of England.

Prosthesima latreillei, Sim., 1879.

1879. *Prosthesima latreillei*, Sim., *Ar. de France.*
1881. ,, *latreillei*, Camb., *Spid. Dorset.*

Adult females of this species, generally regarded as rather rare, occurred in Parkhurst Forest, Isle of Wight, amongst coarse grass, on September 9th.

Prosthesima pusilla (C. L. Koch), 1833.

? 1775. *Aranea nigrita*, Fabr., *Syst. Ent.*
1833. *Melanophora pusilla*, C. L. Koch, *Deuts. Ins.*
1861. *Drassus pusillus*, Bl., *Sp. G. B. I.*
1879. *Prosthesima nigrita*, Camb., *Spid. Dorset.*

A female of this species was taken in a meadow near St. Leonards on June 11th.

Family SPARASSIDAE.

Sparassus viridissimus (De Geer), 1778.

1757. *Araneus roseus*, Clk., *Sv. Spindl.* (= ♂) (Pre-Linnean).
1757. ,, *virescens*, Clk., *Sv. Spindl.* (= ♀) (Pre-Linnean).
1778. *Aranea viridissima*, De Geer, *Mém.*
1793. ,, *smaragdula*, Fabr., *Syst. Ent.*
1806. *Micromata smaragdina*, Latr., *Gen. Crust. Ins.*
1861. *Sparassus smaragdulus*, Bl., *Sp G. B. I.*
1861. ,, *ornatus*, Westr., *Ar. Suec.*
1867. ,, *ornatus*, Bl., *Ann. Mag. N. H.*
1881. *Micrommata virescens*, Camb., *Spid. Dorset.*

My friend, Mr. C. R. Percival, of Walthamstow, kindly presented me with two adult females of this beautiful species, taken in the High Woods, Bexhill, Sussex, during the summer of the present year.

On September 9th I took a half-grown specimen, also of the female sex, in Parkhurst Forest, Isle of Wight.

Family THOMISIDAE.

Xysticus kochii, Thor., 1870.

1845. *Xysticus viaticus*, C. L. Koch, *Die Arach.* (*nom. praeoc.*).
1870. ,, *kochii*, Thor., *On European Spiders.*
1881. ,, *viaticus*, Camb., *Spid. Dorset.*

This fine crab-spider appears to be rare in many parts of the country, especially in the northern areas. In the Hastings district, however, it is quite abundant, and there, in the early part of June, I collected adult specimens of both sexes in half a dozen different localities. I might here mention, perhaps, an interesting incident concerning this species. My wife and myself were ascending the steps leading to East Cliff, at Hastings, when we noticed a blow-fly hovering in a most peculiar manner several feet from the ground. We promptly captured the fly in order to investigate the matter, and found attached to its abdomen an adult male of *Xysticus kochii*. The spiders' fangs were driven deeply into the body of the fly, which appeared to be suffering from the effects of the poison; in fact, it died shortly afterwards. This is the first instance which has come before my notice of a spider actually being carried a considerable distance by its intended prey, although I have several times seen spiders jerked off their feet by a powerful victim. The males of the *Thomisidae*, however, would seem to be of all spiders the most suitably formed for such an exploit, for their long, horizontally extended legs and flat bodies would enable them to firmly clasp their victims without impeding the movements of the wings.

Family SALTICIDAE.

Attus caricis, Westr., 1861.

1861. *Attus caricis*, Westr., *Ar. Suec.*
1869. „ *riparius*, Sim., *Monog. Attid.*
1872. „ *atellanus*, Sim., *Revis. Attid.*
1881. „ *caricis*, Camb., *Spid. Dorset.*

A single male specimen of this rare Salticid was kindly forwarded to me with other spiders by our member Mr. W. Pinkerton, who found it amongst moss at Watford, in Hertfordshire.

Phlegra fasciata (Hahn.), 1831.

1831. *Attus fasciatus*, Hahn., *Monog. Aran.*
1848. *Euophrys aprica*, C. L. Koch., *Die Arach.*
1851. *Attus niger*, Westr., *Ar. Suec.*
1881. *Phlegra fasciata*, Camb., *Spid. Dorset.*

Two males of this uncommon species were taken at Camber, near Rye, Sussex, amongst the coarse grass of the sand-dunes, on June 12th, 1907.

Hyctia nivoyi (Lucas), 1842.

1842. *Salticus nivoyi*, Lucas, *Exp. Algér.*
1881. *Hyctia nivoyi*, Camb., *Spid. Dorset.*

This extremely local jumping-spider, remarkable chiefly on account of its narrow elongate form, occurred in some numbers amongst the sand-dunes at Camber, near Rye, on June 12th, 1907. The specimens were mostly immature, the few adults being of the female sex.

Toxeus formicarius (De Geer), 1778.

1778. *Aranea formicaria*, De Geer, *Mém.*
1846. *Pyrophorus helveticus*, C. L. Koch, *Die Arach.*
1861. *Salticus formicarius*, Bl., *Sp. G. B. I.*
1881. *S. formicarius*, Camb., *Spid. Dorset.*

Toxeus formicarius is one of our rarest, handsomest, and most interesting spiders, whose presence in Britain has hitherto been attested only by several isolated records extending over three-quarters of a century. In the supplement to the *Encyclopaedia Britannica*, 4th, 5th, and 6th editions, it is recorded from Scotland on the authority of Dr. Leach; but one might well be excused for doubting its occurrence so far north. A specimen taken by Mr. C. Waterhouse at Southend is stated to be in the British Museum; and another example, taken by Mr. J. C. Dale near Lymington, is, I believe, in existence. The late F. O. Pickard-Cambridge informed me that there was a fourth record, but did not furnish any details. It will be evident from the nature of these data that the knowledge of a locality where the species could be definitely stated to occur in something like reasonable numbers has always been a desideratum amongst arachnologists, and the recent discovery of such will doubtless be of interest to all students of the spiders.

At the end of the first week in September, at the invitation of my friend Mr. Frank Morey, of Newport, Isle of Wight, I was able to spend three days in this charming neighbourhood, with the object, primarily, of adding to the local list which my host

is assiduously preparing for future publication. Shortly after my arrival I was shown a number of dried spiders, collected many years ago by Mr. Morey, and amongst them I at once noticed a specimen of *T. formicarius*, marked "June 19th, 1886, Luccombe Chine." Mr. Morey very generously presented me with this specimen, and I should have visited Luccombe in the hope of finding more had I not deemed it advisable, owing to the shortness of my visit and my host's desire for a good "list," to avoid spending any time in railway journeys. The next day we visited Parkhurst Forest, a fine stretch of woodland, which I regret has recently been closed to the public. Here, in several spots, I noticed an undergrowth consisting of coarse grass, plentifully intermixed with small, often hidden gorse plants. Knowing a little concerning the habits of *Toxeus* from Continental records, I determined to carefully work these undergrowths, and, towards evening, was rewarded by finding a young specimen of the coveted spider. This decided the next (the last) day's programme, when seven hours' work produced several more immature examples and three adult males.

The only satisfactory method of working this gorse-besprinkled undergrowth is a very uncomfortable one. One has to lie flat down, and forcibly separate the refractory herbage almost to the roots, for the spiders construct small silken tubes amongst the dense grass quite close to the ground. I have tried lying upon thick cloth, etc., to avoid the gorse prickles, but found the addition more of a nuisance than an advantage, as one is constantly crawling backwards or forwards, and the cloth either gets in the way or is left behind. The prickles, too, manage to find their way through almost anything, and it is a question whether one is more disconcerted by the many stabs which are expected than by the occasional ones which come unawares. Of course one's enthusiasm at the time discounts the pain considerably, and the physical damage is far more evident the next day, when the enthusiasm has somewhat diminished. Gloves, too, although affording some amount of protection, are by no means conducive to profitable work: seeing a spider is one thing, but catching it is quite another matter. Two more remarks which apply to the collection of spiders generally, but particularly to such species as *T. formicarius*, which frequent sunny situations and move rapidly, may not be out of place here. In the first place it is a dangerous

practice to lie with one's back exposed for a considerable time to the full heat of the sun. On more than one occasion I have nearly fainted from neglecting the precaution of a shade for the head and back. A small leafy branch or a bundle of bracken makes a fairly good shade in an emergency, and it should be remembered that creatures can be detected far more easily in shadow than in direct sunlight. Secondly, should a creature, believed to be a prize, be escaping rapidly into some recess where it is difficult for the moment to attempt to capture it with the fingers, pour the contents of the spirit tube over it. This will disconcert it considerably, and will thus give the collector a decided advantage. For this, and many other reasons, a number of tubes of spirit should be carried in preference to one larger bottle.

Toxeus formicarius is chiefly remarkable as being one of those spiders which are apparently protected by their resemblance to ants. The mature male might be mistaken for *Formica rufa* (these ants abounding in the same locality), but not by a practised eye. The immature specimens, however, are far more difficult to distinguish from a smaller ant, which occurs commonly amongst the coarse grass. The female is unknown to me, but as a rule in ant-like spiders the male more nearly approximates the species "mimicked."

We have another rare spider in Britain which is closely allied to *Toxeus*. It is known as *Synageles venator*, Luc. From this species *Toxeus* may be easily recognised by its larger size, and by the falces of the male which, although varying somewhat in different individuals, are always enormously developed, and directed almost horizontally forward.

Family AGELENIDAE.

Amaurobius terrestris (Wid.), 1834.

1834. *Aranea terrestris*, Wid., *Zool. Misc.*
1836. *Amaurobius tigrinus*, C. L. Koch, *Deuts. Ins.*
1837. ,, *subterraneus*, C. L. Koch, *Uebers.*
1889. *Coelotes pabulator*, Camb., *Proc. Dors. F. Club.*
1900. ,, *terrestris*, Camb., *List Br. Ir. Spid.*
1900. ,, *pabulator*, Camb., *List Br. Ir. Spid.*

This very rare spider has occurred on several occasions in the Hastings district. Mr. W. Ruskin Butterfield, the curator of the

local museum, who kindly gave me a specimen, informed me that he had found the species fairly common in the neighbourhood. A good deal of searching, however, resulted only in the capture of a single specimen, a female, on East Cliff (June 7th). This species might be mistaken for the common *A. atropos* (Walck.), but the differences are, under the microscope, quite obvious. Excellent figures of both are given by Kulczynski in *Bull. Acad. Sciences de Cracovie*, 1906. I know of no locality in the South where *A. atropos* (Walck.) is at all abundant. In the North, however, it appears to be quite common.

Cicurina cinerea (Panz.), 1793.

1793. *Aranea cinerea*, Panz., *Faun. Ins. Germ.*
1793. ,, *cicurea*, Fabr., *Ent. Syst.*
1871. *Cicurina cicur*, Menge, *Preuss. Spin.*
1879. *Tegenaria cinerea*, Camb., *Spid. Dorset.*

This species has been found on several occasions in Epping Forest, between Chingford and High Beech, in cavities on the underside of felled tree-trunks. It also occurred at St. Leonards in early June.

Family LYCOSIDAE.

Tarentula miniata (C. L. Koch), 1834.

1834. *Lycosa miniata*, C. L. Koch, *Die Arach.*
1848. ,, *nivalis*, C. L. Koch, *Die Arach.* (*ad partem*).
1881. *Tarentula miniata*, Camb., *Spid. Dorset.*

This rare species occurs amongst the coarse grass on the sand-dunes at Camber, near Rye, in Sussex, where on June 12th, 1907, I found both sexes adult. It may be roughly distinguished from several allied spiders found in similar localities by its hoary appearance, but subsequent careful microscopical examination is necessary in order to definitely fix the identity of the species. The important characters are figured on Pl. 14, Figs. 1 *a*, *b*. *T. miniata* may be expected to occur in any coast area where there are tracts of blown sand and marram grass.

Tarentula nemoralis (Westr.), 1861.

1848. *Lycosa nivalis*, C. L. Koch, *Die Arach.* (*ad partem*).
1861. „ *nemoralis*, Westr., *Ar. Suec.*
1872. *Tarentula meridiana*, Thor., *Rem. on Syn.*

A male and female of this fine species, now for the first time recorded as British, were taken by myself in the Bexhill High Woods on June 21, 1907, amongst grass sheltered by a large stone. *T. nemoralis* (Westr.) is extremely closely allied to *T. miniata* (C. L. Koch), but may be distinguished by a careful examination of the palpus of the male and the epigynum of the female (Pl. 14, Figs. 2 *a*, *b*). The female taken appeared to be not quite adult, and I am unable therefore to give a detailed drawing of the epigynum. The outline sketch (Fig. 2 *b*) will, however, give some idea of the form of this organ, which, according to Continental writers, is very pale even when fully developed.

Lycosa agrestis, Westr., 1861.

1861. *Lycosa agrestis*, Westr., *Ar. Suec.* (*ad partem*).
1867. *Pardosa arenaria*, Ohl., *Ar. Prov. Preuss.* (*ad partem*).
1870. *Lycosa decipiens*, L. Koch, *Jahrb. K. K. Gel. Ges. Krakau.*
1903. „ „ Camb., *Proc. Dors. F. Club.*
1907. „ *agrestis*, F. P. Smith, *Journ. Quekett Club.*

I was fortunate enough to capture a female of this exceedingly rare British spider on Pan Down, Shide, Isle of Wight, on September 8th, 1907. This is the third time that the species has occurred in this country. The first specimen was taken by myself probably during 1901, but it was overlooked amongst some commoner species, and the locality was, unfortunately, not noted. This was not recorded until 1907 (*Journ. Quekett Club*, Ser. 2, Vol. x., p. 16). The Rev. O. Pickard-Cambridge, meanwhile, had recorded a specimen from Stratford-on-Avon in 1903 (*Proc. Dorset F. Club*, vol. xxiv., p. 161), under the name of *Lycosa decipiens*, L. Koch. The Isle of Wight specimen is a very distinctly marked one, the lateral bands of the thorax being clearly broken up into a series of spots.

Lycosa farrenii, Camb., 1871.

1871. *Lycosa farrenii*, Camb., *Trans. Linn. Soc.*
1881. „ „ Camb., *Spid. Dorset.*
1903. „ „ Camb., *Proc. Dorset F. Club.*
1907. „ *ferruginea*, F. P. Smith, *Journ. Quekett Club.*

Since my communication upon the genus *Lycosa* in the last number (No. 60) of this Journal, Dr. A. Randell Jackson has very kindly forwarded for my inspection male and female specimens of the above rare spider. The Rev. O. Pickard-Cambridge's statement in *Proc. Dors. F. Club*, vol. xxiv., p. 160, that this species is identical with *L. ferruginea*, L. Koch, is certainly incorrect; and my own action of sinking *L. farrenii* as a synonym of *L. ferruginea*, based upon this statement, is consequently invalid. Mr. Cambridge's species is a very fine and remarkable one, totally different from any other *Lycosa* known to me. I am now able to figure its more important characters (Pl. 14, Figs. 3 *a*, *b*, *c*), and to append the following brief description: Length: male, 6 mm.; female, 7 mm. Ground-colour, pale orange-brown, legs rather darker. Cephalothorax with a central pale band, almost parallel, narrowing somewhat in its posterior fourth. On each side of this, running from level with the posterior eyes straight backward, is a reddish-brown band. The remaining clear space is divided about half-way by a very narrow longitudinal broken band of a brownish tint, and the extreme edges are clearly lined with dark brown. The abdomen is rather paler than the cephalothorax, and has a row of greyish, oblique, broken bands or rows of blotches on each side which do not join in the centre but leave a clear band. In the male only the under-side of the abdomen, from the rima to the spinners, is thickly covered with curious swollen hairs, each in shape very much resembling a shoemaker's awl, the handle end being attached to the integument. Legs with strong spines, and marked, especially on upper sides of femora, with distinct brown spots, from many of which the spines spring. Sternum of same colour as cephalothorax, with a darker patch at the junction of each leg. Male palpus with tibia of a swollen form. Female genitalia thickly covered with pale hairs directed backwards.

Family ARGIOPIDAE.

Nesticus cellulanus (Oliv.), 1789.

1757. *Araneus cellulanus*, Clk., *Sv. Spindl.* (Pre-Linnean).
1789. *Aranea cellulana*, Oliv., *Ency. Méth.*
1802. „ *crypticolens*, Walck., *Faune Par.*
1834. *Linyphia pallidula*, Bl., *Researches in Zool.*
1864. „ *crypticolens*, Bl., *Sp. G. B. I.*
1879. *Nesticus cellulanus*, Camb., *Spid. Dorset.*

It is not easy to form anything like an accurate idea as to the abundance or rarity of this species, as it seldom occurs except in dark cellars or underground caverns. I secured an adult female specimen at St. Leonards by removing a coal-plate which the householder had kindly neglected to fasten.

Family LINYPHIIDAE.

Genus **Enidia**, F. P. Smith, 1904.

Genus **Falconeria**, F. P. Smith, 1904.

My proposition of these two genera (*Journ. Quekett Club*, Ser. 2, Vol. ix., p. 115) has called forth prompt criticism from several sources, chiefly on account of my having stated that Dahl substituted *Hypomma* for *Dicyphus*. This statement was obviously a *lapsus calami*, being exactly what I wished to demonstrate that Dahl did *not* do.

So far as I can judge, the facts of the case are as follows :—

In *Preuss. Spin.*, Menge, in 1869, formulated the genus *Dicyphus* for three species :

D. tumidus, Menge (= *bituberculatus*, Wid.).
D. cilunculus, Menge (= *cornutus*, Bl.).
D. bicuspidatus, Menge (= *elevatus*, C. L. Koch).

He also, at the same time, selected *D. tumidus* as the type.

In 1884 Simon, in *Arach. de France*, formulated the genus *Dismodicus* for two species, *D. bifrons*, Bl., and *D. elevatus*, C. L. Koch. He does not, however, appear to have definitely selected either species as the type.

In 1886 Dahl, in *Monog. Erig.*, placed under the name *Hypomma* two species, *H. bituberculata*, Wid., and *H. bifrons*, Bl.

In the first place this settles the type of *Dismodicus*, Sim., for one species, *bifrons*, is here withdrawn, leaving *elevatus* as the type. In the second place the question arises, "Is *Hypomma* a a new genus, *sensu stricto*, or is it in substitution for *Dicyphus*, whose type it includes?" Were it possible to accept the latter alternative I should not have hesitated to have done so, for by regarding Dahl's action as a case of substitution we should have avoided the necessity for sinking *Hypomma* as a synonym. Such a course is, however, rendered impossible by Dahl himself, for he effectively forces our hands by using the genus *Dicyphus* in the very same paper. Whatever may be our wishes, we are bound to accept Dahl's own statement made at the time, and his action in employing *Dicyphus* is absolutely as definite as if he had written, "*Hypomma* is a totally new genus and not intended to replace *Dicyphus*." *Dicyphus* therefore still requiring a new name, I proposed *Enidia*.

With regard to the further history of *Hypomma* it seems straightforward enough. We first determine its type, a simple matter because it contained but two species, one of which (*bituberculata*) could not serve, being the type of *Dicyphus*. The other species, *bifrons*, is therefore the type of *Hypomma*. Simon, in 1894, selects *bifrons* as the type of *Dismodicus*, but this he has no power to do, since Dahl's withdrawal of *bifrons* in 1886 irrevocably settled the matter by leaving *elevatus* as the type. As long as *bifrons* and *elevatus* are held to be congeneric, the name *Dismodicus*, having priority, will stand, and *Hypomma* sinks as a synonym. Should these species ever be separated, then *Dismodicus* will serve for *elevatus* and *Hypomma* for *bifrons*.

Enidia is employed by Rev. O. P. Cambridge for two species, *bituberculata* and *cornuta*. This, of course, is merely a matter of personal opinion, not affected by any laws of nomenclature. The species *cornuta* I separate as the type of the genus *Falconeria*, differing by the possession on the hind metatarsus of a sensory seta. (I hardly think in the present state of our knowledge that we are justified in ascribing auditory functions to these bristles, although probability points in that direction.) As I have before stated, the decision as to whether these setae can be regarded as generic characters is a question for the individual, and I should not mention the matter here but for the fact that the two objections most generally put forward seem extremely weak.

The first objection is the existence of many intermediate forms of bristle, which render it a matter of difficulty to decide, in some cases, whether the organ is a sensory seta or merely a slender vertical hair. This is, of course, exactly what we should expect to find, these exquisitely delicate setae having no doubt developed from tactile hairs. But all that we are at present concerned with is the presence or absence of a certain well-developed seta upon a certain leg-joint.

The second objection is hardly worth mentioning, certainly not worth discussing at any length. It is that these setae, on account of their excessive tenuity, are easily dislodged, and may thus lead to error. Surely this is merely the admission of one's own clumsiness in collecting, or of one's inability, in the case of specimens collected by inexperienced persons, to detect the very distinct cup or "pocillum" which remains after the seta is detached. I would admit, however, that apart from this, *bituberculata* and *cornuta* form quite a neat and reasonable genus, and that on grounds of convenience alone no one would think of separating them. It is a theoretical rather than a practical question, and one upon which authorities seem about equally divided.

Lophomma subaequalis (Westr.), 1851.

1851. *Erigone subaequalis*, Westr., *Goteb. Handl.*
1871. *Walckenaera fortuita*, Camb., *Trans. Linn. Soc.*
1879. ,, *subaequalis*, Camb., *Spid. Dorset.*
1900. *Tapinocyba subaequalis*, Camb., *List Br. Ir. Spid.*
1906. *Lophomma subaequalis*, F. P. Smith, *Journ. Quekett Club.*

This species occurred throughout the Hastings area during June, being particularly plentiful upon a little ledge on the face of East Cliff, almost directly above the shaft of the dust-destructor, and several hundred feet above sea level.

Entelecara acuminata (Wid.), 1834.

1834. *Theridion acuminatum*, Wid., *Zool. Misc.*
1863. *Walckenaera altifrons*, Camb., *Zoologist.*
1879. ,, ,, Camb., *Spid. Dorset.*
1906. *Entelecara acuminata*, F. P. Smith, *Journ. Quekett Club.*

Entelecara erythropus (Westr.), 1851.

1851. *Erigone erythropa*, Westr., *Goteb. Handl.*
1862. *Walckenaera borealis*, Camb., *Zoologist.*
1879. ,, *erythropa*, Camb., *Spid. Dorset.*
1906. *Entelecara erythropus*, F. P. Smith, *Journ. Quekett Club.*

These two species occurred in great abundance throughout the first three weeks of June, 1907, upon stone gate-posts, copings of walls, and iron railings in many parts of St. Leonards. The male of the former may be easily distinguished by the greatly elevated caput, as figured in *Journ. Quekett Club*, Ser. 2, Vol. ix., Pl. 1, Fig. 1. The females, however, require very careful examination to separate them, and several published figures of the epigynal parts of these species being very imperfect and misleading, I hope to be able in a future communication to illustrate the specific characters of this sex.

Description of Plate 14.

1 *a*. *Tarentula miniata* (C. L. Koch). Palpal organs of male in profile, viewed from outer side, × 70.
1 *b*. ,, ,, (C. L. Koch). Epigynum, × 70.
2 *a*. *Tarentula nemoralis* (Westr.). Palpal organs of male in profile, viewed from outer side, × 70.
2 *b*. ,, ,, (Westr.). Epigynum, × 70.
3 *a*. *Lycosa farrenii*, Camb. Palpal organs of male viewed from beneath, × 70.
3 *b*. ,, ,, Camb. Epigynum, × 70.
3 *c*. ,, ,, Camb. Face and falces, viewed from in front × 22

NOTICES OF BOOKS.

Principles of Microscopy. By Sir A. E. Wright, M.D. (Dublin), F.R.S.; Hon. D.Sc. (Dublin), Hon. F.R.C.S.I. 10 × 6½ in. 250 pages, with many illustrations. London: Archibald Constable and Co., Ltd. Price 21*s.* net.

This most valuable work is a treatise upon the microscope, both simple and compound, considered from a purely optical standpoint. The tyro might well, after glancing casually through its pages, replace it upon the bookshelf under the impression that it was something beyond his possibilities; but let him commence at the beginning and conscientiously follow the author's demonstrations, and he will be surprised at the vast amount of valuable information which he can thus acquire with the expenditure of a very moderate amount of intellectual effort. The subject is treated in a thorough and systematic manner, and is neatly divided and subdivided to facilitate reference. There is an air of business-like earnestness about the whole work which cannot fail to produce a favourable impression upon those for whom it is intended—those, in the author's own words, who desire to master the scientific principles of microscopy.

A noteworthy feature of this work is the insertion of a large number of experiments, most of them capable of being performed with nothing more than the most homely apparatus; and every experiment has for its purpose the demonstration and forcing home of some point which might otherwise be overlooked or forgotten. A simple but very effective one, for example, is that shown on Plate II. *e*, where a pattern of white discs upon a black ground is seen as black discs upon a white ground by bringing the eye beyond its range of accommodation. (This is reversed in the description of the experiment—a matter, however, of little consequence.)

In connection with these experiments there is affixed to the cover of the book a little pocket which contains a neatly mounted grating of 400 lines to the inch, which enables the student, without further outlay, to personally verify many of the facts concerning diffraction, a subject which has been brought so prominently before microscopists by the theories of Professor Abbe.

The work includes eighteen plates, mostly diagrammatic, and

often printed in several colours, and nearly one hundred figures in the text. We can strongly recommend it to every one who desires to acquaint himself with the theory of the microscope or who wishes to add to his present knowledge of the subject.

F. P. S.

MICROSCOPY. By Edmund J. Spitta, L.R.C.P. (Lond.), M.R.C.S. (Eng.), F.R.A.S., F.R.M.S., etc. $5\frac{1}{2} \times 8\frac{1}{2}$ in. xx. + 472 pp., with 17 plates and 241 figures in the text. London: John Murray. Price 12*s.* 6*d.*

A passing notice of this work must suffice, as it would seem altogether out of place for the Club critically to review the work of its own President. We cannot, however, refrain from warmly congratulating the author upon his practical successes in photomicrography, as strikingly exemplified in the plates with which this volume is embellished.

F. P. S.

CATALOGUES.—We have received from several opticians catalogues of microscopes and appliances, of which two seem deserving of special mention.

C. Baker, of High Holborn, is responsible for a very complete list of microscopes and microscopical apparatus, and is to be complimented upon the exceedingly systematic arrangement adopted. The extremely varied assortment of articles which a modern first-rate optician is expected to stock renders cataloguing a by no means light task, and we are always grateful to a firm who issue a list of which the arrangement is intelligible to the public as well as to themselves. This catalogue is supplemented by a list of second-hand instruments, which is issued quarterly, with the exception of the June quarter.

R. & J. Beck, of Cornhill, have produced a catalogue of microscopical apparatus which is really a work of art, and, in addition, contains a wonderful amount of valuable information concerning the employment of the appliances described. The series of apparatus for the examination of pond organisms is particularly complete, from the ancient frog-plate to the modern compressors.

F. P. S.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on March 15th, 1907, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on February 15th were read and confirmed.

Messrs. J. A. Robertson, William Browett, and Cecil Worssam were balloted for and duly elected members of the Club.

Mr. Conrad Beck, F.R.M.S., gave a demonstration on "The Illumination of Opaque and Unmounted Objects." A large number of microscopes were arranged to illustrate the points dealt with and the apparatus usually employed. It was stated that the principle of all opaque illumination is to throw upon the object a small and very brilliant image of the source of light. With low powers, say from 3 in. to $\frac{1}{2}$ in., the light can be thrown upon the object by means of either the bull's-eye condenser or the side condenser. The following points in manipulation of the bull's-eye condenser should be observed:—(1) The light should be as near as is convenient, say about 10 in. (2) The light, bull's-eye, and object should be in line. (3) The light should be above the level of the stage as high as the object-glass will admit, so that the shadows shall not be exaggerated. (4) The bull's-eye should be so placed that a small image of the light source is focussed on the object. Character of illumination—one-sided. A second method of using the bull's-eye enables opaque objects to be examined with powers such as $\frac{1}{6}$ in. or $\frac{1}{8}$ in. The following points to be observed: The light to be slightly below the level of the stage. Bull's-eye to be placed, flat surface upwards, almost touching the stage. The edge of the lamp-flame should face the stage. A beam of light is reflected from the flat surface, and condensed by the curved surfaces into a flat feather in an almost horizontal direction. The shadow will be very marked owing to the great obliquity of the light, and for this reason surfaces to be examined must be almost plane. For low powers a more

brilliant illumination may be obtained by the use of the silvered side reflector. A bull's-eye is used to parallelise the light, the light to be level with the reflector, and the bull's-eye to be centred on the same line.

The most powerful and best opaque illuminator is the parabolic side silver reflector. This is fitted to the object-glass itself. It is very simple to use, and throws light upon the object from 180° of arc. The Sorby reflector and the Lieberkuhn were also shown, and their advantages and disadvantages pointed out. The next exhibit was the thin glass reflector at the back of the object-glass. This is a very good illuminator of the Sorby type, and consists of a transparent thin glass placed at an angle of 45°. It does not reflect so much light as the silvered mirror, but does not obscure any portion of the objective. The Beck thin glass illuminator consists of a transparent thin glass disc used at an angle of 45°, placed in a revolving adapter fitted into the nosepiece and above the objective. Light is thrown on the thin glass through a hole in the adapter, and is then reflected by the glass disc on to the object, the objective acting as a condenser and focussing the light upon the object, thus forming a very powerful all-round illuminator. This form of illuminator is difficult to use with dry lenses unless the object is uncovered, as a strong glare is generally caused, due to reflection from the cover-glass. The prism vertical illuminator and the new Rosenhain reflector were also shown.

On the motion of the President, a very hearty vote of thanks was accorded to Mr. Conrad Beck and to his assistant for the demonstration just given.

The Hon. Secretary said that he had received a letter from one of their members, Mr. J. Carrington, P.O. Box 48, East London, South Africa, in which he offered to exchange material and asked for correspondence on microscopy.

A paper on "Water-bears, or Tardigrada," by Mr. James Murray, was read by Mr. D. J. Scourfield.

Mr. Scourfield made a few remarks on the "encystment" of Tardigrada, which Mr. Murray had been fortunate enough to observe. This encystment occurs in the following manner: At some moultings the animal remains within the old skin, becomes darker in colour, and the legs almost disappear, becoming small knobs. About a week later another cyst is formed inside the previous one, and looks very like an egg. At first all the organs

are plainly visible; but in about a week all traces of structure, with the occasional exception of the eye-spots, disappear. Mr. Scourfield said it had been suggested that the "simplex forms" of Richters were these encysted individuals redeveloping their organs. With regard to the position of the Tardigrades in systematic classification, they were usually placed in the Arachnida close to the Mites, but the segmentation of the appendages is very weakly developed, the pharynx is strikingly like what occurs in some worms, such as Nematodes, and there are no traces of a tracheal system.

After some discussion of the paper, Mr. D. J. Scourfield, F.Z.S., F.R.M.S., read a paper on "An Alona and a Pleuroxus new to Britain." The first described was *Alona weltneri*, Keilhack. The specimen had been taken as long ago as 1895 by Dr. T. Scott, in a little pool on the Castle Hill at Scarborough, but had never been recorded. It is closely allied to the fairly common *Alona costata*, but the post-abdomen is quite characteristic. The second, *Pleuroxus denticulatus*, Birge, Mr. Scourfield had obtained on August 30th, 1905, from a small pond close to the railway station at Exminster, Devonshire. It is a typically American species, and apparently has not been previously recorded on this side of the Atlantic. It may therefore have been recently introduced, and it will be interesting to know whether it succeeds in establishing itself in this country.

At the meeting of the Club held on April 19th, 1907, Dr. G. C. Karop, F.R.M.S., Vice-President, in the Chair, the minutes of the meeting held on March 15th were read and confirmed.

Messrs. F. R. T. Lucas, Alfred J. Pownall, T. A. Ford, and C. W. Littlejohn were balloted for and duly elected members of the Club.

Mr. Conrad Beck gave a demonstration on the comparison of objectives, and illustrated his remarks by a number of microscopes arranged to show the apparatus and methods usually employed for that purpose. Members were reminded that objectives can only be properly compared when their distinguishing characteristics are known. For the microscopist only two things are required to be known: (1) the magnifying power, (2) the aperture. Various methods of measuring the magnifying power were shown—from a simple method suitable for use with low powers

to more accurate methods employing a stage micrometer and a camera lucida. The essential points to be observed when using any of the methods demonstrated were clearly pointed out. Wright's Eikonometer—a very convenient piece of apparatus designed to the same end—was also exhibited. The use of the eyepiece micrometer in measuring the size of objects when the magnifying power of the particular combination of objective, eyepiece, and tube-length employed is known, also received attention. The last exhibit was an improved form of the Cheshire Apertometer. This consists of a circular disc of glass with a mark on the upper surface, to which the object-glass to be tested is focussed. The lower surface of the disc is ruled with a series of concentric rings, each of which is placed so as to correspond to ·1 N.A. The method of use was to place the Apertometer on the stage, and focus the cross-lines ruled on the upper surface. The eyepiece is then removed, and the number of rings visible in the back lens of the object-glass is counted. This number equals the N.A. of the objective examined. For high powers a special eyepiece, which focusses to the back focal plane of the objective, is inserted in place of the usual eyepiece.

The Hon. Secretary read a list of recent presentations, the chief of which were forty preparations, chiefly of scale insects and mites, from the collection of the late Rev. J. R. Ward, of Natal, presented to the cabinet by Mr. R. T. Lewis, F.R.M.S.; twenty-three preparations of fresh-water Rhizopoda, presented by Dr. E. Penard. These, with a previous donation of twenty-two, make a valuable type collection, which will be of very great use for identifying specimens to any members taking up the systematic study of this group.

Mr. D. J. Scourfield, F.Z.S., F.R.M.S., said that it had been thought that a few words about fresh-water rhizopods would be a suitable introduction to the paper by Dr. Penard which was to follow. He said he was glad of the opportunity of directing attention to a group of organisms which has been very much neglected—not neglected so much, it is true, as the Tardigrades, about which a paper was read at the last meeting of the Club, but certainly not receiving from our microscopists the attention deserved. This seems rather strange, as these little animals are very plentiful, and are externally very beautiful, often with delicately formed and perforated tests. The problems in connec-

tion with these lowly creatures are also of great interest. The chief works on the group are Leidy's *Fresh-water Rhizopods of North America*, Penard's *Faune Rhizopodique du Bassin du Léman*, and a recently issued first volume of a monograph on the subject in the Ray Society's series by Mr. J. Cash, of Manchester. Mr. Scourfield then said a few words on the nature and classification of rhizopods, and called attention to some of the chief types. Rhizopods (root-footed animals) are unicellular organisms, for the most part of very simple structure, belonging to the lowest of the four main divisions of the Protozoa. A black-board diagram and a description of *Amoeba* as a typical form were given. Some differences of opinion exist as to the use of the word "Rhizopoda." Leidy includes all the forms of the lowest division of the Protozoa; but it is more usual now, perhaps, to limit the term to those forms which have lobelike or filiform pseudopodia, and so to exclude the Heliozoa (sun animalcules) and the Radiolaria (Polycystinae, etc.). Taking the word in its restricted sense, the Rhizopoda fall pretty naturally into three groups, according to the nature of their pseudopodia, viz.: (1) Lobosa: *Amoeba*, *Difflugia*, etc. (2) Filosa: *Euglypha*, *Cyphoderia*, etc. (3) Reticulosa: Foraminifera. The lobose rhizopods are characterised by their lobe-like pseudopodia, which may be blunt or pointed, but never thread-like; and they never anastomose, but may branch a little. Filose rhizopods are characterised by thread-like pseudopods, which branch a good deal and occasionally anastomose. In the Reticulosa the pseudopods are thread-like, much-branched, and freely anastomose. As to the number of fresh-water rhizopods, it may be interesting to note that Leidy, in his great work, only admitted twenty-four genera and sixty species, excluding Heliozoa. The number admitted by Penard and other recent authors is something like 250 species, belonging to, perhaps, sixty genera. This great increase is not because the rhizopod fauna of North America is less rich than that of Europe, for the forms are practically cosmopolitan, but is partly due to the fact that Leidy was rather conservative in the matter of genera and species, and figured many forms under one name which are now considered good species. There is no doubt, however, that the main increase is due to the employment of better lenses and closer attention to details of structure, both of protoplasm and shell. In concluding his remarks, Mr. Scourfield said

that there was here a good opportunity for work with the highest powers of the microscope, and that it seemed to him a great pity that so many good achromatic and apochromatic objectives should be employed simply to resolve diatom structures which had been resolved a thousand times before; while such practice was good training for the expert manipulation of the instruments, it should be considered simply as a preliminary to higher things.

Mr. Scourfield then read a paper on "The Collection and Preservation of Fresh-water Rhizopods," communicated by our honorary member Dr. Eugène Penard, of Geneva.

Considerable discussion followed, in which Messrs. Earland, Bryce, Karop, and Stokes took part.

At the meeting of the Club held on May 17th, 1907, Dr. E. J. Spitta, President, in the Chair, the minutes of the meeting held on April 19th were read and confirmed.

Messrs. J. Drinkwater, B. Drinkwater, C. E. Graham, J. W. Ogilvy, and Captain C. Ackerman were balloted for and duly elected members of the Club.

Mr. F. W. Watson Baker, F.R.M.S., gave a demonstration dealing with "Some Methods of Ascertaining the Qualities, Defects, and Characteristics of Micro-Objectives." The first point treated was the determination of the equivalent focus of objectives by Abbe's method. This method gives the true equivalent focus of an objective as well as the position of its upper focal plane, and is obtained by two measurements of a stage micrometer with different extensions of draw-tube. The principle of the method is that there is no magnification at all in the upper focal plane itself, and that the magnification increases uniformly by one diameter, for every increase of the distance between the upper focal plane and the projected image by an amount equal to the equivalent focus. The method was practically shown in the first microscope then exhibited. A stage micrometer divided to one-hundredth of a millimètre was the object employed, and an eyepiece micrometer divided to one-tenth of a millimètre used in a Huyghenian eyepiece, the field-lens of which had been temporarily removed, as is absolutely necessary for this purpose. When the draw-tube was racked right in, it was observed that the spaces of the stage micrometer covered 18·6 spaces of the eyepiece micrometer, the

magnification being therefore 18·6 diameters. With the draw-tube racked right out, 10 spaces of the stage micrometer are observed to be equal to 28 spaces of the eyepiece micrometer, equivalent to a magnification of 28 diameters. An increase, in this case, of 73 mm. has therefore produced an increase in magnification of 9·4 diameters, and, on dividing the first number by the second, according to Abbe's rule, the equivalent focus of the objective is found to be 7·8 mm. On multiplying this latter figure by the magnification found in the second measurement, it is found that the upper focal plane of this objective lies 217 mm. below the eyepiece micrometer, and by applying a millimètre scale it is found that the upper focal plane of this objective lies 14 mm. below the shoulder of its standard screw. The second stand was arranged to show "why resolving power is dependent on aperture." The Abbe Apertometer was next dealt with; several stands were arranged showing the normal use of the apertometer, its limitations, and method of using with an objective, having a large back lens. The differences between ordinary and compensating eyepieces received due attention, and were well shown on stands having an Abbe test-plate as an object. The Abbe test-plate was also used in succeeding exhibits as a test for spherical aberration, chromatic aberration, defects in the centring of the lenses of an objective, and to show the effect of varying cover-glass thickness. There was also exhibited in an adjoining room the Watson-Conrady apparatus for photo-micrography, in which the chief point to notice was that the usual large and entirely uncorrected condenser is replaced by a small but strictly achromatic and aplanatic condenser of $2\frac{1}{4}$-in. diameter and 3-in. focus, acting in conjunction with an auxiliary iris. It was shown that this form is considerably more efficient than that usually employed, and actually leads to gain in light owing to the perfect transparency of the comparatively small and thin condenser lens in contradistinction to the usual thick and green common condensers.

Mr. F. Chapman, A.L.S., F.R.M.S., communicated a paper on "Recent Foraminifera of Victoria."

Mr. A. Earland said that before proceeding to give an abstract of Mr. Chapman's paper, which would be extremely valuable as a work of reference, but which he feared would not prove very interesting reading to members present, he had been asked to say

a few words on the subject, and proposed to deal briefly with methods of collection, and then to touch upon some of the more interesting features of the life-history of the Foraminifera. Foraminifera—at any rate, so far as the shore species were concerned—were easily obtainable, and their preparation was simple, and did not involve the use of chemical reagents. Probably every one had noticed that on most sandy beaches the sand in the ripple-marks was of a different colour from the rest of the sand. It was generally of a white colour, due to the presence of Foraminifera and fragments of molluscan shells; but sometimes it was dark, or even black, owing to the ashes and coal-dust washed up from steamers. This deposit in the ripple-marks should be carefully scraped together and collected by means of a slip of glass, or, preferably, a strip of thin celluloid, such as a Frena film. It must then be carefully dried at a very moderate heat, and the coarser particles of sand or weed sifted out by means of a wire-gauze sieve of about twenty meshes to the inch. The fine material which passed through the sieve consists of Foraminifera, Ostracoda, fragments of shells, and Bryozoa, mixed with a quantity of sand-grains. The sand-grains could be easily separated, owing to the difference in their specific gravity; but the other organisms were much more difficult to separate; and some objects, such as Ostracoda, which possessed practically the same weight and density as the "forams," could not be separated by any means which did not destroy the objects. If the dried material is placed in a beaker and stirred up with water, it is found that after the greater part of the material has settled to the bottom some remains in suspension or floating on the surface. This can be secured by pouring off the water through a sieve of fine gauze (120 meshes to the inch), such as is used for the collection of pond-life; and, on being dried, it will be found to consist almost entirely of perfect Foraminifera of the smaller and lighter forms, mixed with Ostracoda and small Mollusca. Great care should be used in the collection of these "floatings," as the most delicate and beautiful species are invariably to be obtained by this means. The quantity of floatings varies greatly, according to the nature of the gathering, collections from a muddy shore always yielding the greatest quantity—no doubt because more of the organisms were living when collected, and the drying-up of the protoplasm has sealed up the openings of

the shells, and so rendered them more buoyant. After the floatings have been secured, the next step is to separate the heavier specimens from the sand. In order to do this the material from the bottom of the beaker is poured out into a shallow tray, such as a "half-plate" developing dish, and covered with about an inch of water. The dish is then taken up and rocked gently with a sort of circular sweeping motion. This rocking action of the water causes the light calcareous particles to rise to the surface of the layer of heavy sand-grains, and to collect in eddies. At the proper moment, which is quickly learned by experiment, the water is rapidly poured off into a sieve, and carries the Foraminifera and other light organisms with it. The process is repeated until nothing but sand is left in the dish. The material in the sieve is then carefully dried, and can be preserved for an indefinite period if kept in dry tubes. Dredgings and silt can be cleaned in the same manner; but if much mud is present it should first be removed by washing the material over a sieve of very fine gauze (120 to 150 meshes per inch) under a tap of gently running water. This allows the mud to pass away, leaving the sand and forams behind. The residue can then be treated in the manner already described.

After dealing with some of the characteristic features of the group, Mr. Earland described at some length the *dimorphism* of the Foraminifera. The term "dimorphism" was originally used to describe a change in the method of the arrangement of the chambers during the lifetime of an individual. Thus, a specimen of the genus *Bigenerina* commences its existence with chambers arranged biserially, and subsequently changes to chambers arranged in a single row. The word was, however, now used in a different sense, and referred only to the difference in the size of the first or "primordial" chamber of the test. It was noticed many years ago that Nummulites in various fossil deposits were often associated in "pairs of species," one species being small and the other large, and that the smaller species always had a large primordial chamber, while the larger species had a very tiny one. To account for the fact, De la Harpe enunciated a "Law of the Association of Species in Pairs." Subsequently, Munier-Chalmas expressed the opinion that these pairs were but forms of the same species, and called the form with the large primordial chamber (*megolospheric*)

form A, and the form with the small primordial chamber (*microspheric*) form B. Working with Schlumberger, he found that many other genera and species showed the same difference in the size of the primordial chamber, and that this difference of size was often associated with differences in the method of arrangement of the early chambers. The investigation of this phenomenon has now been carried out in the living organism, chiefly by Schaudinn in Germany, and J. J. Lister in this country, and it has thrown much light on the method of reproduction in the Foraminifera. The main point of difference between the living megalospheric and microspheric forams is found in the character of the nucleus. The megalospheric type has in its early stages but a single large nucleus, while the microspheric type is multi-nucleate. The method of reproduction in the two forms depends on this character, and is as follows: In the microspheric and multi-nucleate type the protoplasm emerges from the shell and collects in a ring of minute globules outside, each globule forming round one of the nuclei. According to Lister, as many as 200 of these globules are simultaneously formed, each of which secretes a shell which is always of the opposite type to the parent—*i.e.* a megalospheric type. The parent then dies, and the young brood disperse. Following up the life-history of these *megalospheric* young shells, which, during the greater part of their life, possess only the single nucleus derived from the parent, it is found that after a time the nucleus disappears, and is replaced by innumerable micro-nuclei. Each of these segregates a particle of protoplasm, and, after repeated subdivisions, the whole of the protoplasm breaks up into a mass of biflagellate spores. What became of these spores was for many years in doubt; but a few years ago Schaudinn observed the conjugation of two spores, and watched the subsequent growth of a *microspheric* shell. The origin of the microspheric shell, which had long been a mystery, was thus solved, and proved to be the result of a sexual process. Dimorphism has now been observed in a great many genera and species, but it would not be safe to say that all Foraminifera are dimorphic, although this probably is the case. The difference in the sizes of the primordial chambers varies very much in the species observed. In *Biloculina* they are about as 15 to 1, but in some others the difference is slight. The size of the adult shell may be very different in the two forms, as in

the Nummulites, or it may be almost identical as in *Polystomella*. Megalospheric specimens are always more abundant than microspheric. Lister examined 2,000 specimens of *Polystomella crispa*, and found the proportions were as 34 megalospheric to 1 microspheric. Mr. Earland then gave a short *résumé* of Mr. Chapman's paper.

At the meeting of the Club held on June 21st, 1907, Dr. E. J. Spitta, President, in the Chair, the minutes of the meeting held on May 17th were read and confirmed.

The thanks of the meeting were accorded to Messrs. C. Lees Curties, junior, H. O. Green, W. O. Walker, and C. Pells for an exhibition of microscope accessories, etc. There were shown micrometers, the Traviss expanding spot for dark-ground illumination, two stands exhibiting objects by polarised light—the analyser being in each case a tourmaline instead of a second Nicol, and on one stand a block-glass polariser was used with a tourmaline analyser. The cheapness of the tourmaline over the usual Nicol, owing to the very small size (about $\frac{1}{8}$ in.) required, was pointed out. The method employed in arranging diatoms, etc., in symmetrical groups was shown, and two forms of an interesting accessory (an auxiliary objective used at the bottom of the draw-tube)—one for converting the microscope practically into a short-focus telescope to be used for exhibiting the whole of large objects which required magnification not greater than about ten diameters, and another, useful for dissecting, which permitted the use of higher powers. Both forms gave erect images.

Mr. C. F. Rousselet, F.R.M.S., read a paper on "*Brachionus sericus*, n.sp., a new variety of *Brachionus quadratus*, and remarks on *Brachionus rubens*, Ehrenberg."

Mr. W. Gardner said he thought members would be very thankful to Mr. Rousselet for clearing up the difficulty of the incorrect figures in Hudson and Gosse. When he began to study this group, some years ago, he soon found several instances in which the descriptions of species did not agree with the figures. He also had found *B. rubens* always associated with Daphnia.

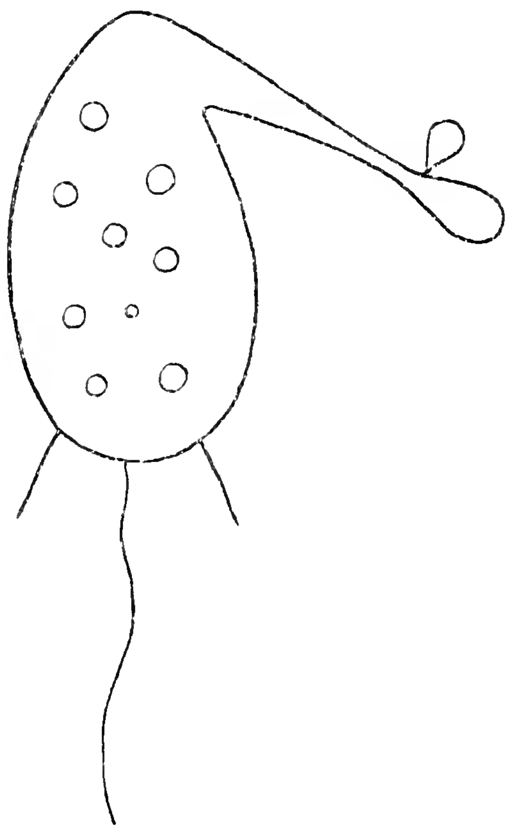
Mr. D. J. Scourfield suggested that the habit of *B. rubens* of "riding" upon *Daphnia* might not indicate a higher state of

intellect as assumed by Mr. Rousselet, but rather a lower type of morality!

The following note by Mr. A. A. C. Eliot Merlin, F.R.M.S., was read by the hon. secretary:

Note on a New (?) Flagellated Monad.

While examining the infusoria in some slightly brackish water containing rotting weed, under a Powell achromatic $\frac{1}{12}$ in. oil immersion objective of measured N.A. 1·27,* a rapidly moving flagellated form was noted furnished with a very curious and interesting appendage which, when viewed sideways, gave to the whole monad the shape of a chemist's retort. The creature



when first seen was entangled in and its movements hampered by some weed filaments, otherwise the appendage might probably have escaped notice, it being normally carried under the rapidly moving organism so as to form a kind of keel.

I have prepared a rough outline sketch showing the general features of this form. The body, measuring $\frac{1}{2500}$th inch in

* This objective has been found very suitable and convenient for use on living organisms, as it combines sufficient aperture with quite exceptionally great working distance, allowing it to focus through cover-glasses and water-films of considerable thickness; it can therefore be used under conditions where an ordinary oil immersion lens could not be employed.

length and $\frac{1}{5000}$th inch in breadth, is hyaline and exhibits several vacuoles, and in addition to the appendage is provided with a single long powerful flagellum flanked on each side by a stiff bristle.

From the general appearance of this organism it is almost impossible to avoid the inference that some kind of gemmation is here in progress, although no change was remarked during the short time that the monad was under observation (about fifteen minutes), and the matter is brought to your notice in the hope that some member of the Club who has made the study of the smaller infusoria a speciality may be able to throw some further light on the subject. As a rule, such books as I have read, while fully and accurately describing large and coarse forms the details of which are fairly obvious under objectives of small numerical aperture used in a rough-and-ready fashion, are by no means so explicit regarding the host of small varieties whose most interesting features and evolutionary processes can only be demonstrated by good and careful observation with the best appliances. It would seem that there is a boundless field open in this direction for any observer whose tastes incline him to grapple with questions which others have evaded through a preference for easier paths, although it is of course not intended to include in this category a limited number of biological microscopists whose practice has ever been to shirk no difficulties in the pursuit of knowledge.

Mr. Rousselet said that the form observed was apparently one of the "collared monads" which had very hyaline collars.

Mr. D. J. Scourfield agreed with Mr. Rousselet, and said that one did get the appearance of setae, produced by the sides of the very fine funnel. Early figures always represented the "collared monads" with two spines instead of a funnel.

The following communication has been since received from Mr. Merlin in reply to the remarks of Messrs. Rousselet and Scourfield:

"It having been suggested that the organism above figured and described may be one of the 'collared' infusoria, and that the two spines at the posterior extremity of the body are the edges of the imperfectly seen collar, the rest not being visible under the optical combination employed, I venture to point out that the observations were made under strictly critical conditions with a fine Powell objective of measured N.A. 1·27, used in

conjunction with Gifford's screen and an apochromatic sub-stage condenser, the resultant definition being so clear and perfect that personally I can feel no doubt whatever that the features depicted in the figure (sketched at the microscope) truly represent the real structure of the monad, which was carefully observed for a sufficient time to make sure of its characteristics. The side-spines, together with the flagellum flanked by them (situated at the *posterior* extremity of the body, and not at the anterior end), received particular attention in order to determine their comparative lengths, each spine being separately brought into sharp focus. It is not my intention to suggest a new species; indeed, I consider that the organism is probably a common and well-known infusorian, whose true form and appendages have escaped previous notice."

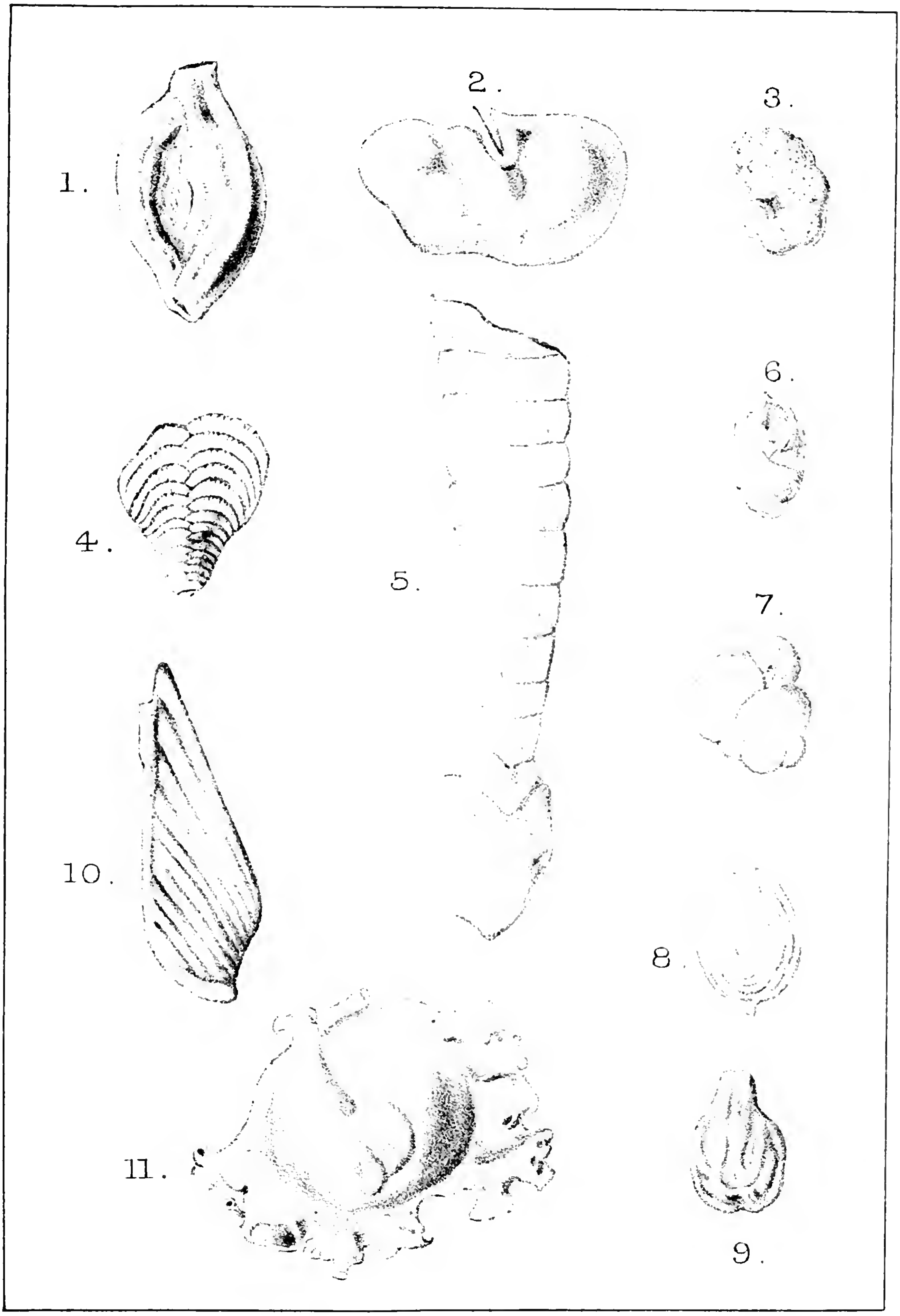
OBITUARY.

CHARLES STEWART, M.R.C.S., LL.D. Aberdeen, F.R.S., F.L.S., F.R.M.S.,

Conservator of the Museum at the Royal College of Surgeons. Died September 27th, 1907.

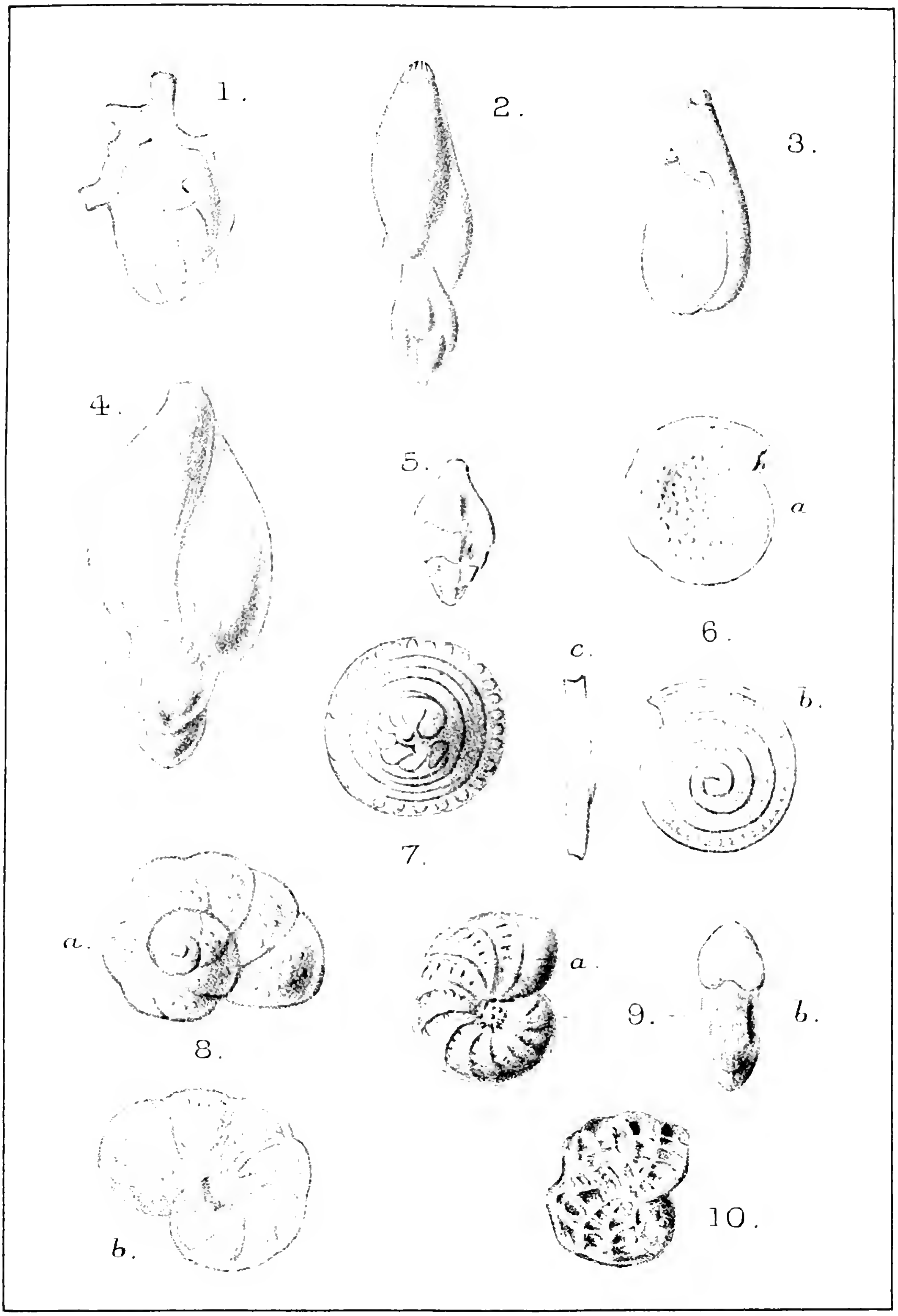
Professor Stewart became a member of the Club in 1877 and remained so until 1905, during part of which time he acted as Vice-President. He took a great interest in the Club's welfare and not infrequently attended its meetings. He wrote but little; but as a lecturer or debater he was unrivalled, being greatly helped by his remarkable skill in blackboard drawing. His remarks were always the expression of his own experience, and bore, in consequence, the impress of his personality, which was charming. As Conservator of the Museum of the Royal College of Surgeons he was *facile princeps*, well maintaining the traditions of his eminent predecessors (among whom was, of course, John Quekett), his Physiological series and display of Adaptive Modifications in the museum testifying to his genius; but at heart he was an open-air naturalist.

By his death we lose an eminent clubman, and those who knew him personally mourn also the loss of a brave and youthful nature.



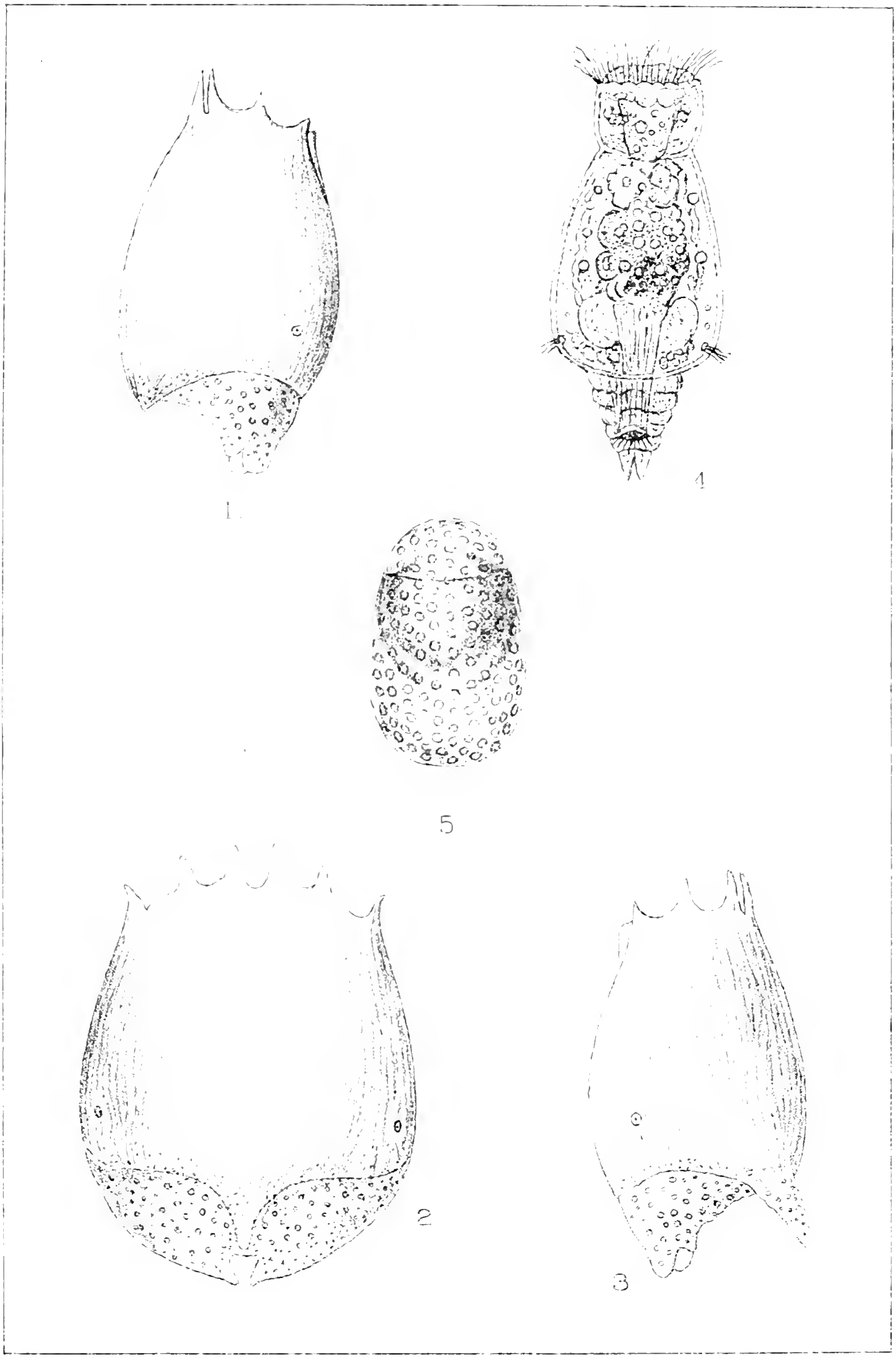
F.C. ad nat. del. × 44. A. H. Searle. lith.

Recent Foraminifera: Victoria, Australia.

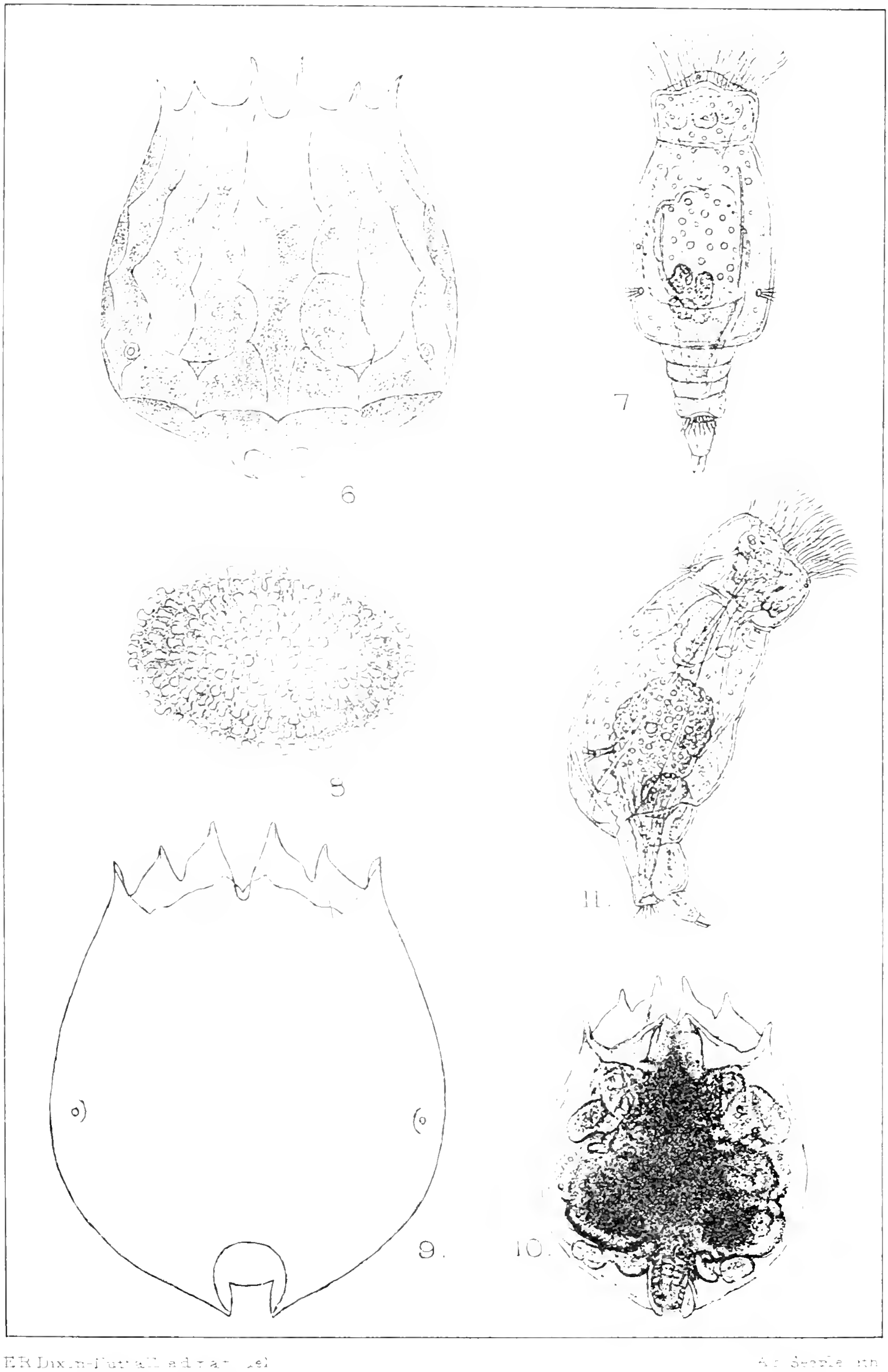


F.C. ad nat. del. A.H. Searle, lith.

Recent Foraminifera: Victoria, Australia.



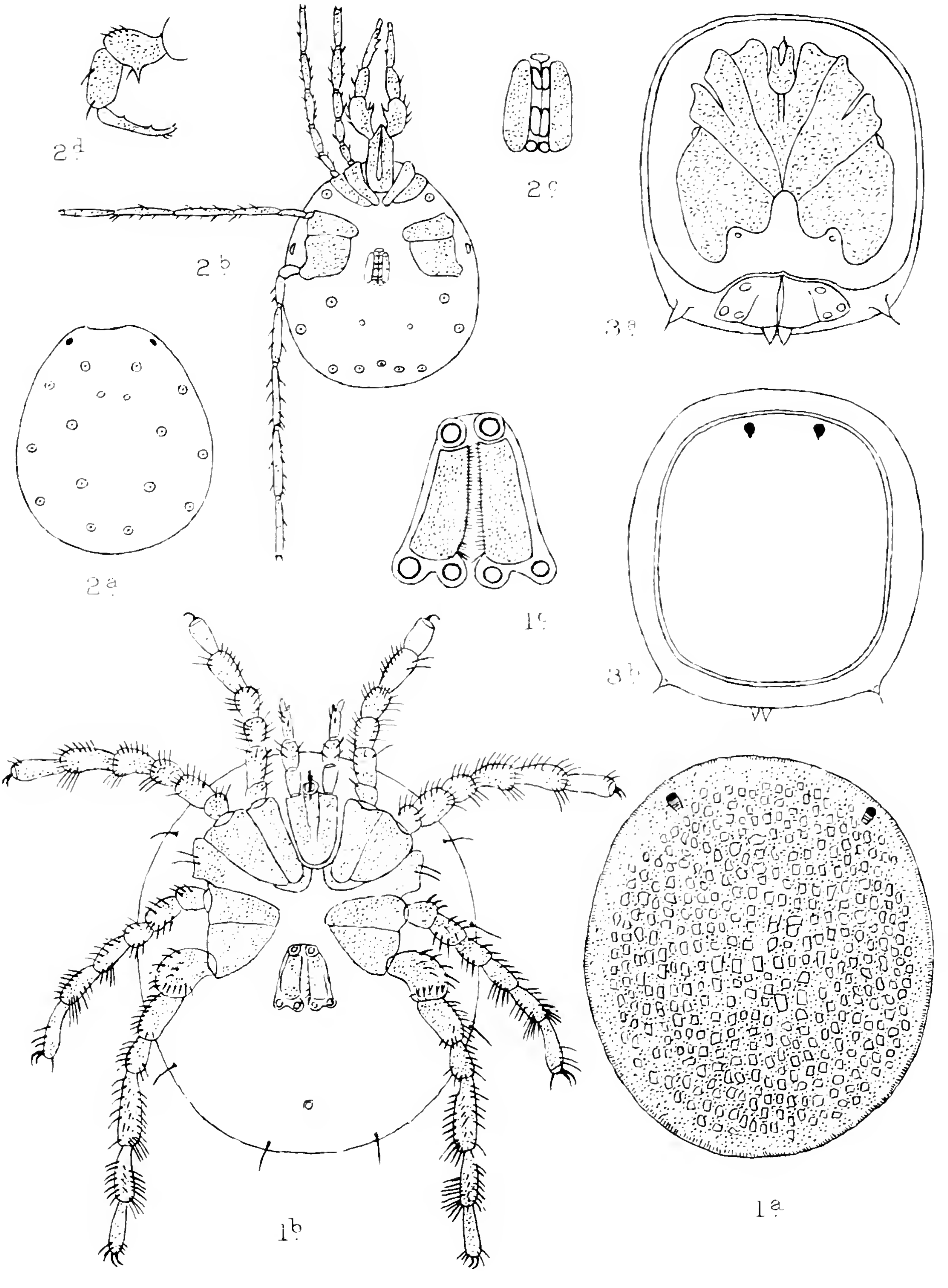
Brachionus Sericus, Sp. N.



E. R. Dixon-Nuttall ad nat. del. A. Searle lith.

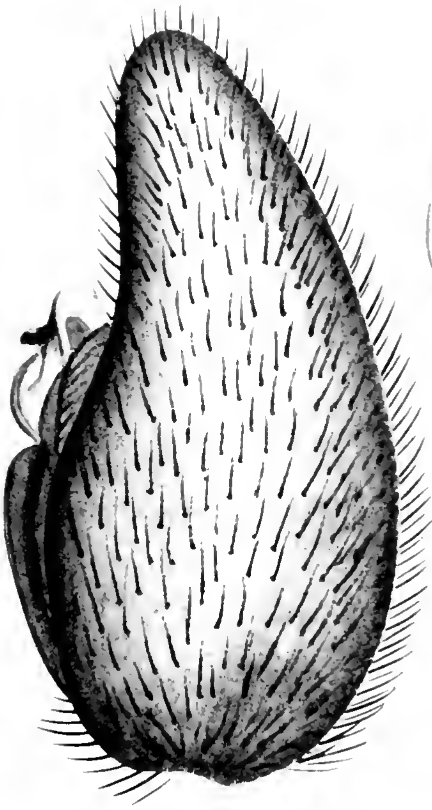
Brachionus quadratus, Var. rotundus.

and Brachionus rubens (Ehrenbg.)



George R. Deeley, ad nat. del. A. H. Searle lith.

British Water-mites.



1a.

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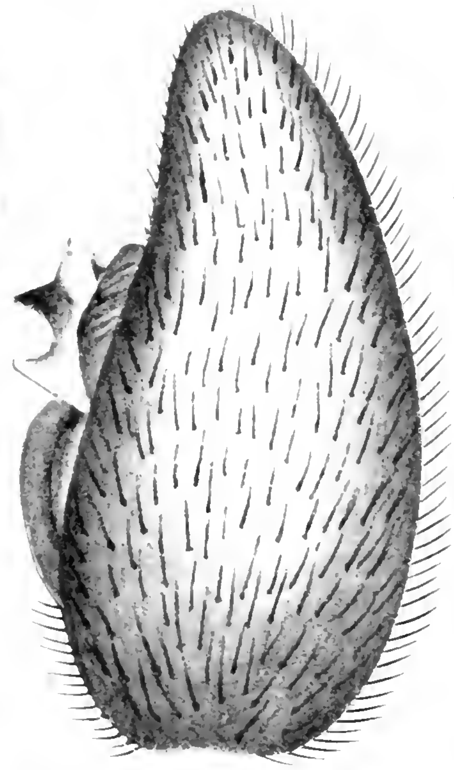

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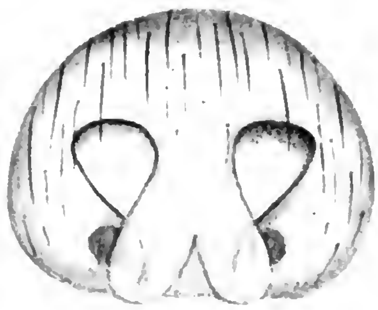
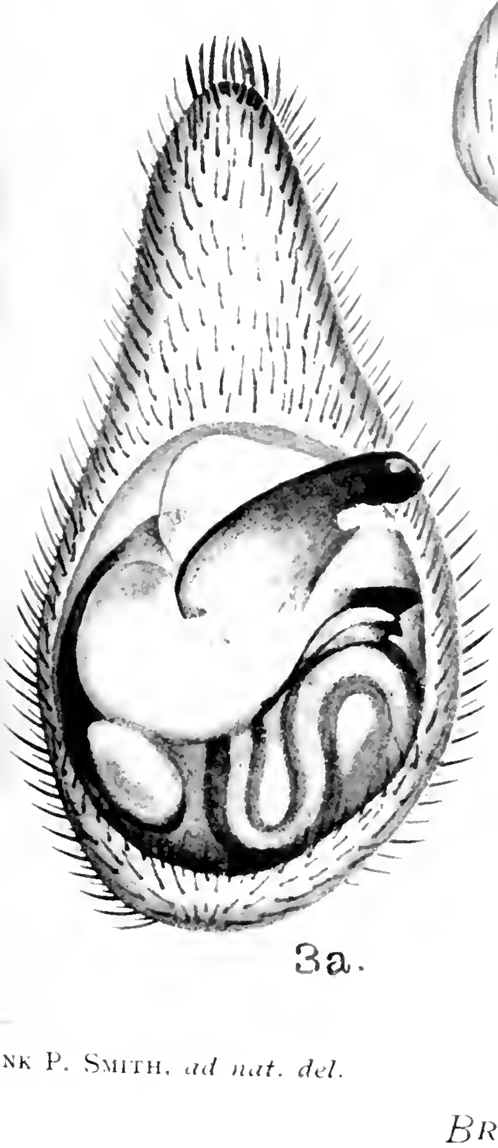


1b.



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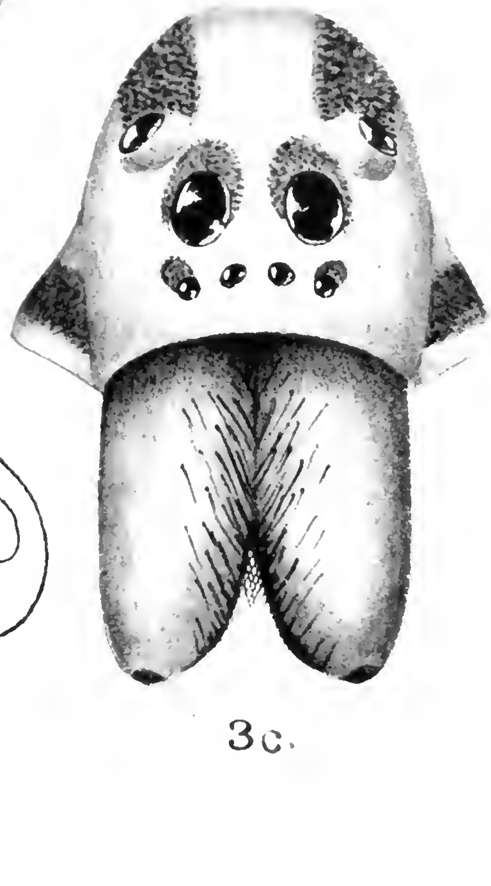

3c.

Frank P. Smith, *ad nat. del.*

British Araneae.

PHILODINA MACROSTYLA, EHR., AND ITS ALLIES.

By James Murray.

(*Communicated by D. J. Scourfield, November 15th*, 1907.)

Plates 15 to 17.

Introduction.

The following study has been undertaken mainly with the object of summarising what is known of an interesting group of Bdelloids, and one which is puzzling to beginners on account of the extreme variability of some of the species included in it, and the fact that the known species are usually placed in two different genera, whereby their relationship is obscured.

The study is by no means exhaustive, as its completion on a long ocean voyage prevented reference to some works in which the species are mentioned, but it is hoped that all the more important forms are noticed. All the forms which I have been able to study in life are figured, as well as one important variety which Mr. Rousselet has kindly permitted me to draw from his excellent mounts.

On the Genus Philodina.

The genus *Philodina* was founded by Ehrenberg in 1830, in the publication in which he made his first attempt at a classification of the Rotifera (6).

His order Zygotrocha, including all Rotifers having the ciliary wreath divided into two parts, contains an illoricated family Philodinaea, which corresponds in the main with the order Bdelloida, as now understood.

The subdivision into genera is made to depend primarily on the presence or absence of eye-spots and their position when present, secondarily on the number of toes. The genus *Philodina* is thus defined—"Oculis duobus, dorsalibus (pone organa rotatoria), cauda ter furcata." In the genus as thus defined he included three species—*P. erythrophthalma*, *P. aculeata*, and *P. citrina*.

The genus *Philodina* I regard as a thoroughly natural one, although it is generally conceded that the eye-spots are too unstable to serve for generic distinction. Very closely related species may be found, one of which has eye-spots, while the other has none. The eye-spots, moreover, frequently fail in species which usually have them. I therefore propose to redefine the genus, making Ehrenberg's secondary character the principal one.

Genus **Philodina**.

Toes four. Eyes cervical or none.

This redefinition makes little change in the *personnel* of the genus—all the species having cervical eye-spots remain in it, with the single exception of *P. hexodonta*, Bergendal, which is probably the same as *P. collaris*, Ehr. That species has only three toes, and in other respects its organisation differs profoundly from all other species having dorsal eyes.

Ehrenberg also defines the genus *Rotifer* as having "cauda ter furcata," but that is undoubtedly a mistake, as the three species which he at first included in the genus, and all species since discovered which have frontal eyes, also have three toes.

The new definition causes to be included in the genus a number of species formerly on technical grounds included in *Callidina*, but which are all of robust frame like the dorsal-eyed species, and agree with them in all essential features.

The number of those *Philodinae* unprovided with eye-spots is not very great as yet, though several have been recently added to the list. The ten known species are *P. plena*, *P. alpium*, *P. brycei*, *P. humerosa*, *P. laticeps*, *P. parasitica*, *P. hamata*, *P. spinosa*, *P. vorax*, and *P. indica*.

There are some sixteen species known which have eye-spots, making a total of twenty-six admitted species in the genus.

The genus is not large enough to be unwieldy, yet those twenty-six species are sufficiently diverse, and it is probable that the generic definition is still too wide.

The species may be arranged in five groups, which are on the whole natural, though one or two species are difficult to place.

First Group.—Oviparous, skin soft, spurs of moderate size. This is the central group, including most of the early species. The spurs are only moderately long, but they form narrow cones and are usually separated by a more or less distinct interspace. *P. flaviceps*, though short-spurred, essentially belongs here. All the species have dorsal eyes and are oviparous. Nearly half the genus is in this section. The species are *P. erythrophthalma*, *P. roseola*, *P. citrina*, *P. megalotrocha*, *P. brevipes*, *P. flaviceps*, *P. decurvicornis*, *P. nemoralis*, *P. acuticornis*, *P. rugosa*, and *P. microps*.

Second Group.—Semi-loricated. The skin of the trunk is very thick and stiff, deeply longitudinally plicate on the dorsal surface, strongly transversely plicate on the ventral surface, scarcely changing shape during movements, the folds merely permitting of expansion and contraction. The three species known have no eye-spots, are oviparous, and have rather small spurs. The species are *P. alpium*, *P. brycei*, and *P. humerosa*.

Third Group.—Parasitic species. Large animals with long narrow foot, and large broad spurs. Though, *a priori*, one might expect that diverse species might take to a parasitic life, it appears in this instance that all the parasitic *Philodinae* are of one stock. Their resemblances are too great to be ascribed to "convergence." The species in the group are oviparous and without eye-spots, except *P. laticornis*, which is viviparous and has eye-spots. The parasitism of that species is less pronounced, and it frequently swims free. The species are *P. parasitica*, *P. commensalis*, *P. laticeps*, *P. hamata*, and *P. laticornis*.

Fourth Group.—Short-spurred. The spurs in this group are not only short, but they are of a type common in the genus *Callidina*, very broad and acuminate, as in *C. quadricornifera*, etc. The species are oviparous, and *P. squamosa* is the only one of the group having eye-spots. That species is a kind of waif, and has perhaps no right here. The species are *P. plena*, *P. vorax*, *P. indica*, and *P. squamosa*.

Fifth Group.—Long-spurred and viviparous. The spurs are extremely long and slender. Every part of the organisation

differs more or less from the rest of the genus. Eye-spots are present or absent. The species are *P. aculeata*, *P. macrostyla*, and *P. spinosa*. It is with this fifth group, the *viviparous, long-spurred Philodinae*, that we have here to do.

P. parasitica, Marchoux, is so vaguely described that it is impossible to tell in which group it should be placed, and unfortunately the author gives no figure.

The species appears to be distinct, but the name has been previously used by Giglioli (9).

VIVIPAROUS PHILODINAE.

Macrostyla Group.

The species of the genus *Philodina* are oviparous, with four exceptions. The three species of the *macrostyla* group are very closely related. The fourth species, *P. laticornis*, has nothing in common with the others, except the mode of reproduction and the possession of four toes.

The group is so distinct from the rest of the genus that I would consider it of generic value, but as the whole order Bdelloida requires revision it would be inadvisable to form a new genus till the group is dealt with.

Historical Sketch.

In 1830 (6) Ehrenberg, after defining the genus *Philodina*, and naming the first species *P. erythrophthalma*, named, without describing, *P. aculeata*, which is the first notice of any species of the group under consideration.

Though it was only then that any of our species received a name, I think it likely that one of them had been previously observed and figured.

Joblot, in 1718 (14), despite his bizarre nomenclature, gives some spirited drawings of Rotifers, which indicate an uncommonly good observer. Some of his species (as *Brachionus pala*, for instance) can be readily identified.

The plate of Bdelloids (Plate 11) represents only species with long spurs. Though Joblot supposed that his "aquatic caterpillars," of which he saw seven or eight, were all of one kind, it is highly probable that in an old infusion there might be several

of the long-spurred species which live well in stagnant water. Several of his drawings show the deep constrictions which characterise *Rotifer tardus*, *R. trisecatus*, *R. longirostris*, and *Philodina macrostyla*, and hardly any other species. He correctly discriminates the rostrum and the antenna (which Giglioli as late as 1863 (**9**) failed to do) when both were displayed together.

The lobed termination of what he calls the "trompe" or rostrum in figure A is suggestive of the antenna of *P. macrostyla*, and the more slender trompe at letter R is strikingly like the antenna in a position it sometimes assumes. The rostrum proper never looks like that, and I think we are justified in identifying that figure (Plate 11, S, R, T) as *P. macrostyla*. He might readily confuse the antenna with the rostrum when both were not extended together. For his descriptions of the "chenille aquatique" see (**14**) part 2, p. 80.

Ehrenberg (**7**), in the year 1831, in his second classification, describes three additional species of *Philodina* and gives a short description of *P. aculeata*.

It was not until 1838 (**8**) in the *Infusionsthierchen* that he described the second species of our group, *P. macrostyla*.

Gosse, in 1886 (**11**), described his *P. tuberculata* apparently unaware of Ehrenberg's *P. macrostyla*, as no comparison is made of the two species. Hudson (1889) in the Supplement to *The Rotifera* withdrew Gosse's *tuberculata*, on the strength of Gosse's own notes and the experience of other observers with *tuberculata* (Western, **19**).

The last species of the group, *P. spinosa*, was described by Bryce (**1**) as *Callidina spinosa* in 1892.

The two earlier described species, *P. aculeata* and *P. macrostyla*, have been much written about, the former especially giving rise to great divergence of opinion, much of which was gratuitous, as the species really varies in different localities.

In 1893 Janson (**13**) described a variety *medio-aculeata* of *P. aculeata*.

So far as I am aware, no other form of the group has received a name, either as variety or species, though some other names of alleged species are believed to be synonymous for *P. macrostyla*.

Among the many forms of *P. aculeata*, there is only one which I consider to be a stable variety. The variety *crystallina* has a very distinct surface texture, which appears to be constant, and no intermediate forms between it and the type have been seen. It is quite as distinct from the three species as they are from one another, but as it has also the dorsal spines precisely agreeing with the commonest Scottish form of *P. aculeata*, I prefer in the meantime to subordinate it to that species.

Form and Structure.

The three species of the *macrostyla* group are so exactly alike in their general organisation, that, if we suppose the two spiny species deprived of their spines, there would remain no other difference between them, except the lack of eye-spots in *P. spinosa*, a character known to be variable in *P. macrostyla*.

A general description of the outward form and internal structure, as far as we need consider it, will fit all three equally well, and the specific differences can afterwards be given in a few words.

It is not intended to enter minutely into structures which are common to all Bdelloids, but simply to describe with sufficient detail the form and proportions of all parts by which the *macrostyla* group is marked off from the rest of the genus.

I have not been able to make any minute study of the organisation and physiology of these animals, valuable though such study would be, had one time for it. Though they are not by any means typical *Philodinae*, they are typical Bdelloids, and there is no reason to think that exhaustive study would show any important departure from the central Bdelloid type. I have made no experiments and traced no life-histories, but simply observed the animals carefully, as far as opportunity and the instruments at my command permitted, and noted all points of form and structure, whether of generic, specific, or merely varietal value, wherein they differ from other Bdelloids and from one another.

Form.—Creeping or feeding the animals have the ordinary

philodinoid shape. The central segments form a broad, barrel-shaped or almost quadrate expansion, which is marked off by deep constrictions from the narrow extremities, both of which taper to very slender terminal segments.

The slender rostrum and foot give a certain resemblance to the animals of the genus *Rotifer*, which are also viviparous. Against these points of correspondence must be set the possession of four toes, of cervical eyes (when any), and of only four foot-joints, instead of the five of most, if not all, species of *Rotifer*.

The constriction anterior to the broad central trunk separates a section of the body, still regarded as part of the trunk (see Figs. 1, 2, 8, 12, etc., on Plates 15 and 16). The central and anterior parts of the trunk are longitudinally plicate, the plicae in the centre of the back broad and shallow, getting narrower and deeper towards the sides. The ventral surface of the central trunk is obscurely transversely plicate, in one variety of *P. aculeata* distinctly so.

The trunk is thick-skinned, rarely hyaline and colourless—more generally more or less yellowish, in consequence of a secretion from the skin, which may cause extraneous matters to adhere, and which often of itself forms a thick casing of plates. The pores which produce the secretion give the surface a strongly stippled appearance, often quite papillose.

In front of the trunk come the three thinner-skinned neck segments, diminishing in size forwards, the third carrying the antenna.

Then follows the oral segment, forming in the creeping attitude, by reason of its bulky contained organs, an expansion.

The oral segment is abruptly contracted to the narrow two-jointed rostrum.

The lower joint of the rostrum is a sheath for the upper joint as usual. The terminal joint is slender, and has its tactile armature very well developed (see Pl. 17, Fig. 18).

The tactile organs are of four kinds—the *lamellae*, the *brush* of vibratile cilia, the *straight setae*, and the large *tactile setae*.

The tip of the rostrum is invertile, and all those organs can be

drawn into it. When fully extended the tip forms a hemispherical prominence, still slightly inverted at the base.

The *lamellae* (Figs. 19–20) are very large. They appear as two plates, soldered in the middle line, and the common plate thus formed standing forward as a flange, and at the extremity bent forwards as a kind of beak (Fig. 20). Laterally the lamellae extend far round, forming a kind of collar, diminishing forward (as shown in Fig. 20), unlike most ordinary Philodinadae.

The *brush* of cilia covers the whole tip. The cilia, of which it is composed, act in concert, with a kind of automatic vibratory motion, like those of the discs.

The *straight setae* spring from the tip, close to the base of the lamellae. They radiate from the tip, close under the lamellae, and are distinguished from those of the brush mainly by the absence of motion. In these viviparous *Philodinae* they rarely project beyond the lamellae, and are thus very difficult to detect. In most other *Philodinae* they are better developed.

The *tactile setae* are more conspicuous in this group than in any other Bdelloids which I have studied. There are four, two on each side of the tip. The two setae of each pair are close together at the base, and spring from the tip, close to the lamellae. They are thick, long, tapering, and undulate. They are put out as feelers before the tip is everted, and their movements do not appear automatic like those of the brush, but intelligent.

The *antenna* is a highly-developed organ, and conspicuously differs from that of other Bdelloids. It is apparently three-jointed or obscurely four-jointed, tapering from the base to the beginning of the last joint, which is expanded at the tip into a three-lobed cup, in the centre of which is a clavate process, from which groups of setae diverge (Pl. 15, Fig. 7, and Pl. 17, Fig. 18). In side view the antenna has a curious resemblance to a human arm, with bent elbow and clenched fist (Fig. 7). The articulation is best studied in this view. There is first the large short basal joint *a*, then a short joint *b*, at the end of which is the elbow, then a long, tapering joint *c*, small at the base and again slightly near the distal end;

lastly the terminal joint *d*, wrinkled in its narrow basal portion, and expanded at the end, as already described.

Despite the apparent four joints, I regard the antenna as consisting of the usual two joints. The basal joint *a* is considered to be an extension of the skin of the neck, forming a sheath for the antenna proper, the separation between *b* and *c* as a false joint to permit of the elbowing. This fold is obscure on the convex side of the elbow, and I have never seen *c* drawn into *b*, as we would expect if they were truly distinct segments.

The neck-segment bearing the antenna has the common dorsal processes on each side of the antenna (see Section Fig. 18). This section is of *P. tuberculata*, Gosse, and this example, at least, had two knobs on each side of the antenna.

Head.—When the oral segment is expanded, displaying the corona and mouth, some distinctive features are exhibited, when compared with other Philodinadae.

Corona.—In dorsal view the discs usually appear rather small, but their apparent size varies greatly with the angle at which they are carried. This arises from the fact that they are farther apart dorsally than ventrally, and if they are inclined forward only the dorsal edge is seen. If they are less inclined forward, the cilia of the ventral edge are also seen, making the disc seem broader.

I have never managed to detect central setae on the discs of any of the species of the group ; but considering that extremely delicate setae have been found on the discs of some species of the genus *Rotifer*, and their usual presence in other Bdelloids, I expect that they will be found present here also.

Pedicels.—The two convex lines connecting the discs, and meeting at an angle in the median line, are not the boundary lines of the upper lip proper, as in most Bdelloids. They represent the pedicels of the discs, seen on account of the unusual feeding attitude, the upper lip being lower down, nearer the rostrum. This constitutes a further resemblance to the genus *Rotifer*.

Eyes.—Ehrenberg states that the eyes of *P. aculeata* are round, and those of *P. macrostyla* oblong. I cannot regard this distinction as valid. In both species I have seen both round and

oblong eyes, and it appears to depend on the point of view which appearance they have. *P. spinosa* has no eyes. Eckstein (**5**) and Janson (**13**) found the eyes always oval, never round, in *P. aculeata.*

Jaws.—The two jaws together form an almost circular body. Each jaw has a thick brown border, and bears three equal teeth. Ehrenberg described both *P. aculeata* and *P. macrostyla* as having three teeth in each jaw. Dr. Burn (**3**) and Mr. Western (**19**) suppose this to be an error as regards *P. macrostyla*, and that the usual arrangement is three teeth in one jaw and two in the other. In my experience there are normally three equal teeth—very rarely one tooth in each jaw is smaller, as in the typical *Philodina.*

Bryce (**2**) in 1893 says that he found the dental formula to be 3/2 in two examples of *P. spinosa.*

Rump and Foot.—The posterior portion of the body, considered by the earlier naturalists as the foot, is now regarded as consisting of two portions, that part after the anus being now alone defined as the foot. I have proposed the name *rump* for the narrowed portion between the central trunk and the anus. This usually has only two segments, the preanal and the anal; but may include the fourth central.

In the viviparous Philodinadae the rump is separated from the central trunk by a sharp constriction. The homologies of the segments of the rump are here rather obscure. I am inclined to think that the constriction occurs between the third and fourth central segments, and that it is this segment which forms the first expansion of the rump and bears the last pair of spines in the spiny forms.

When seen well extended this part of the body has a nodose appearance with three or even four nodes.

Foot.—The foot consists of four joints. The first is longer than the second, which is very short. The third, or penultimate segment, which bears as a rule the spurs, is short. It is swollen at the base, then forks, forming two rounded cushions, which support the spurs (Fig. 24).

Spurs.—The spurs are always very long and slender, relatively longer than in other Bdelloids, except perhaps *Rotifer neptunius*, Milne, and *Rotifer actinurus*, Ehrenberg.

They have prominent shoulders on the inner side at the base. They diverge and taper from the base, and are either outcurved or incurved at the tip, or else somewhat undulate. The longest spurs which I have measured were 75 μ in length.

Toes.—The ultimate foot-joint, which bears the toes at the extremity, is long and slender. It acts as a sheath for the toes. The toes are all very slender, and consist of a larger and a smaller pair. The long pair are two-jointed, the shorter doubtfully so. The unusual position of the toes, all close together at the end of the joint, makes the distinction of dorsal and ventral pairs less obvious than in other *Philodinae* (Fig. 25).

By analogy with other Bdelloids the long toes would be ventral, or terminal.

The shorter toes are extremely small, and are so nearly between the longer ones that their position offers no evidence as to whether they are dorsal or ventral.

Philodina aculeata, Ehrenberg.

1830. Ehrenberg (**6**) p. 49 (name only).
1831. Ehrenberg (**7**) p. 148 (description).
1838. Ehrenberg (**8**) p. 501, Plate 61, Fig. 9.

Ehrenberg's diagnosis, 1831 (**7**), p. 148, is in the following terms: "Längendurchmesser $\frac{1}{48}$–$\frac{1}{6}$.''' Körper gestreckt, blass gelblich. Mittelkörper mit weichen Stacheln oder Hörnchen besetzt, welche das Thierchen willkürlich aufrichten kann. Augen rund. Sporn mit kugelförmigen Ende."

In that description the only character of importance in distinguishing this from other species is the possession of spines. The description would embrace also Bryce's *P. spinosa*; but as Ehrenberg defined the genus as having dorsal eyes, that species is separated by the lack of eyes.

The figure shows an animal possessing as many as twenty-seven spines, two of which point forward, the others backward.

I do not know that the animal figured by Ehrenberg has been seen by any subsequent observer.

Authors who refer to and figure the numerous spines, as Dujardin (**4**) who says the animal is "tout herisée d'épines,"

Pritchard (**17**), etc., have probably only followed Ehrenberg. Miss Glascott (**10**) claims to have seen an animal answering to Dujardin's description; but her own description is evidently of another animal than Ehrenberg's, and in all probability an unnamed species.

The form with most numerous spines among those which I have seen might, if seen in lateral view, give the impression that the spines are more numerous than they really are, as will be understood by looking at Fig. 16, where only eleven or twelve of the thirteen spines are seen.

This supposition does not explain Ehrenberg's dorsal view (copied from Pritchard in Fig. 22), which shows closely-set spines all round the lateral margin of the trunk, as many as seven on each side.

It is rarely that more than two pairs of the backward-pointing spines reach to the lateral margin or project over it.

Subsequent observers are agreed in identifying as Ehrenberg's *P. aculeata* an animal possessing a much smaller number of spines, varying from two to thirteen (the largest number I find recorded), symmetrically arranged in pairs, or with an additional median spine in one row.

All the spines have their points directed backward, except the pair which is furthest from the median line of the body and a little in front of the widest part of the trunk, which point forward.

This pair is partly or wholly hidden among the skinfolds when the animal is creeping—when fully contracted the tension of the skin forces the points outward, till they stand almost at right angles to the trunk, when they may be supposed to form a deterrent to any animal thinking of having *aculeata* for dinner.

Ehrenberg (**7**) asserts that the spines can be erected at will, and Janson (**13**) says that they are movable and can be laid against the body.

No doubt the spines are sometimes erect and sometimes laid close to the body; but it seems to me that the movement is automatic, and that it is misleading to say that it is done at will. The spines seem to be rigidly joined to the skin, and to assume

different positions with the varying tension of the skin; and this is also Weber's view (**18**).

Ehrenberg's description is very indefinite; but if the animal usually identified as *P. aculeata* is really that species, it is so variable that all the laxity of the original diagnosis is necessary in order to embrace all the forms.

Failing the rediscovery of Ehrenberg's type, the form having the largest number of spines (13, in Janson's var. *medio-aculeata*) might be regarded as the type from which all the varieties have been derived by the suppression of one or more pairs.

Weber (**18**) regarded as the type a form having eleven spines, including a median; but without the forward-pointing spines.

Eckstein (**5**), in 1884, found always ten spines, in pairs, all directed backward.

Milne (**15**), 1886, found always eight spines, in pairs, one pair directed forward.

Gosse (**11**), 1886, describes and figures eleven spines, including anterior-median and lateral forward-pointing spines, and differing from Janson's *medio-aculeata* only by the absence of one dorsal pair.

Rousselet has mounted, and kindly lent me, examples of the variety *medio-aculeata* (figured in Pl. 17, Figs. 16-17).

There follow short descriptions of all the forms which I have personally examined. Though no one, so far as I can find, has noticed a twelve-spined variety, that is by far the commonest in Scotland.

13 Spines.

P. aculeata type = var. *medio-aculeata* Janson (**13**) (Figs. 16, 17, drawn from mount by Rousselet).

Spines: 1st row, anterior, of three spines of moderate length; 2nd row, a pair of very long spines, springing from skinfolds nearer the middle line than the outer spines of the 1st row; 3rd row, a pair of short spines, on the lateral skinfolds, directed forward; 4th row, a pair of long spines, on skinfolds farther from the median line than those of the 2nd row; 5th row, a pair of short spines, on folds near the middle line; 6th row, a pair of short, divergent spines, on the segment after the

constriction marking the limit of the central trunk (this segment I believe to be homologous with Bryce's 4th central segment). In all the descriptions the supposed homologous rows of spines will be indicated by the same numbers, 1 to 6.

12 Spines.

Variety.—One of the commonest forms in Scotland, and having the largest number of spines which I have been able to study in the living animal. The spines correspond exactly with those of var. *medio-aculeata*, except that the anterior median spine is absent. I have not seen the median spines in any Scotch examples, nor has Milne (**15**). (See Fig. 1.)

Var. *crystallina* var. nov. (Figs. 8, 9). Spines twelve, in six pairs, one lateral pair pointing forward, corresponding with those of var. *medio-aculeata*, but the median spine lacking. Trunk covered with large hemispherical tubercles, which form longitudinal rows on the dorsal, and transverse rows on the ventral surface. The plication of the trunk includes the tubercles between the folds, so that they do not appear as prominences in the profile of the body.

The whole trunk is clean, and free from any secretion, and beautifully hyaline.

This variety, having real tubercles, might be taken as Gosse's *P. tuberculata*, but the spines distinguish it. Gosse describes the tubercles as rough, and the colour as dark brown, which makes it highly probable that he had in view examples of *P. macrostyla* having the trunk coated with deep plates formed of a viscous secretion.

The var. *crystallina* is one of the most beautiful of Bdelloids. It recalls *Callidina formosa*, Murray (**16**), but in that species the tubercles crown the skinfolds, and thus appear on the profile, while in this they are between the folds, and do not show on the outline.

This gives ordinarily the appearance of simple wrinkling, but careful study shows that these are really independent tubercles, of extreme uniformity of size and regularity of disposition.

I have never seen this variety with any trace of the viscous

coating which frequently characterises *P. macrostyla*, and more rarely the type and some varieties of *P. aculeata*.

Frequent, among moss, in the highlands of Scotland, from Loch Morar to Shetland.

11 Spines.

The form described by Gosse has eleven spines. As Gosse states that in the contracted state the last pair of spines appears to terminate the body, it is probably the 5th pair which is lacking in this form.

Weber's 11-spined form has the 5th pair of spines, but lacks the lateral spines. This form I have not seen.

Certain authors have supposed that the lateral spines, which at times stand out vertically to the surface of the trunk, or point forward, may be laid down backward like the other spines, but I believe this to be an error, and that when they disappear as the animal creeps, they are laid down forward between the skinfolds.

10 Spines.

Variety.—The five pairs of spines are the 1st, 2nd, 3rd, 5th, and 6th. The lateral pair of spines is present; the absent pair is the sublateral 4th pair (Fig. 12). The 1st pair is reduced to rounded knobs. The 2nd pair is longest of all, as in the type. Near Glasgow.

Variety.—The five pairs of spines are the 1st, 2nd, 4th, 5th, and 6th. The forward-pointing lateral spines alone are lacking. The second pair are longest (Fig. 23).

Variety.—The spines are, as in the preceding variety, pairs 1, 2, 4, 5, and 6. The 1st and 2nd pairs have reversed positions as to size, the 1st being very large and strong, while the 2nd are the shortest of all.

8 Spines.

I have seen no form, having less than eight spines, which possessed the lateral pair of spines, directed forward. Mr. Milne's variety has this pair; so far as can be judged from his very slight figures, the spines are the 1st, 2nd, 3rd, and 4th; the 5th and 6th absent.

Variety.—The spines are pairs 2, 4, 5, and 6. They have broad expanded bases and short blunt tips. The 6th pair are low cones, almost hemispheres (Figs. 13, 14).

Variety.—The spines are also pairs 2, 4, 5, and 6. They are reduced to mere hemispheres, with no trace of narrowed apical portion (Fig. 11).

Spines fewer than 8.

Forms having six, four, and two spines have also been observed, thus completing the gradation from the most spiny forms to *P. macrostyla*, and rendering it doubtful whether the two species can be maintained. As both species have varieties, or perhaps merely states, corresponding to Gosse's *tuberculata*, their discrimination requires care. On several occasions animals which appeared to be typical *tuberculata* were found, when the viscous secretion was rubbed off, to be *P. aculeata*.

Of the forms having less than eight spines no detailed studies are available. The spines of the four-spined form were the 2nd and 4th pairs.

Philodina macrostyla, Ehrenberg.

Ehrenberg, C. G.—"Die Infusionsthierchen als vollkommene Organismen," Leipzig, 1838, p. 501, Plate LXI. fig. vii.

Ehrenberg's diagnosis is as follows: "Ph. alba, laevis, ocellis oblongis, pedis corniculis basalibus praelongis." He found the animal near Berlin, and noticed that there were three teeth in each jaw, and remarked on the correspondence with *P. aculeata* in this character. He speaks of a respiration-tube, thickened at the anterior end and ciliate (antenna?).

This rather meagre description is still sufficiently distinctive. A *Philodina* with very long spurs, three teeth, and oblong eyes can only be *P. macrostyla* among known species. The only other species having these characters is *P. aculeata*, and it is distinguished by its spines.

Ehrenberg gives the length of the animal as $\frac{1}{6}$th of a line, and the length of the egg as $\frac{1}{36}$th of a line.

The last statement requires consideration, as all the species of the group we are dealing with are supposed to be viviparous.

Ehrenberg states that *P. aculeata* is periodically viviparous. In all my experience of all three species I have found no confirmation of this, the species being uniformly viviparous. Janson (**13**) also expresses doubt of Ehrenberg's statement.

Ehrenberg may possibly have mistaken the embryo at an early stage for an egg, but it is not yet demonstrated that the mode of reproduction is invariable.

P. tuberculata, Gosse (**11**), (Plate 15, Figs. 3, 4) I consider to be not even a variety, but merely a condition of *P. acrostyla*. The protective secretion is particularly abundant, and when the animal is dormant it forms a very thick coating, consisting of a number of plates, corresponding to the longitudinal and transverse folds of the skin of the trunk. This coating may persist for a long time after the animal resumes activity, but can be rubbed off by rolling under a cover-slip.

Both the type and the tubercled form are among the commonest rotifers in Scotland, and occur in many situations. They are especially frequenters of peat bogs, and live well in very dirty water. *P. tuberculata* has been found living in a small bottle which had been completely filled with evil-smelling mud and tightly corked for twelve months.

Philodina spinosa (Bryce), (**1**), (Plate I. Figs. 5, 6).

Bryce, "*Callidina spinosa*," (**1**) 1892, p. 22. "Longitudinal skinfolds and those marking trunk segments armed with very short prickle-like points set closely together, the angles marked with rather longer points. A short spine on centre of ventral margin and a longer one at each lateral angle of anterior edge of first trunk segment. Spurs rather long and of peculiar shape; at first parallel, they are bent outwards at a right angle and thence incurved, so that each describes a quarter-circle, the point being directed downwards and backwards."

I have quoted Mr. Bryce's diagnosis in full, because it illustrates a characteristic of all his work. However incomplete his descriptions may sometimes of necessity be, they are so accurate that the animals can always be readily recognised again.

In this instance he only saw a single example, which was very

timid, and never showed itself to advantage, yet with the diagnosis and figure he gives the animal may be confidently identified.

To the preceding description I have little to add, except that in general form and details of structure this species is precisely like *P. aculeata* and *P. macrostyla*.

It is distinguished solely by the peculiar spines. There appear to be ordinarily no eye-spots, but so few examples have been seen that we cannot yet be certain that this is the normal condition. Individuals without eye-spots are quite frequent in the other two species.

Even without seeing it feed or observing the toes, Mr. Bryce remarked the resemblance to *Philodina*.

In 1893 Bryce (**2**) announced that he had found two other examples of *P. spinosa*, and that the dental formula was 3/2.

This corresponds curiously with the dental formula ascribed by Burn (**3**) and Western (**19**) to *P. macrostyla*.

The probability is that the number of teeth varies; but 3/3 appears to be the commonest formula for *P. aculeata* and *P. macrostyla*.

P. spinosa is not sufficiently known, as only a few examples have yet been seen.

Too much importance must not be put upon the form ascribed to the spurs in the preceding description. This appears to have been an individual peculiarity, and I found the spurs very much as in the other species.

The form of the head when feeding is that common to the group, and the toes are four in number.

Among *Sphagnum*, bog near Fort Augustus, 1903.

I am not aware that any one else has seen the species since its original discovery, so that it appears to be rare.

Janson (**13**), in his monographic study of the family, includes *Callidina spinosa*, but without having himself seen it.

LITERATURE.

This list includes only works referred to in the text. Circumstances render it impossible to attempt a more complete bibliography.

1. Bryce, D. "On the Macrotrachelous Callidinae." *Journ. Quekett Micr. Club*, ser. 2, Vol. V., 1892.

2. Ibid. "On Two New Species of Macrotrachelous Callidinae." *Journ. Quekett Micr. Club*, ser. 2, Vol. V., 1893, p. 197.

3. Burn, Dr. Barnett. *Science Gossip*, Dec. 1889.

4. Dujardin, F. "Zoophytes, Infusoires," 1841, p. 660.

5. Eckstein, K. "Rotatorien der Umgegend von Giessen." Giessen, 1884.

6. Ehrenberg, C. G. "Organisation der Infusorien," etc. *Abhand. K. Akad. Wiss. Berlin* (1830) 1832.

7. Ibid. "Entwickelung und Lebensdauer der Infusionsthiere." *Abhand. K. Akad. Wiss. Berlin* (1831) 1832.

8. Ibid. "Infusionsthierchen." Leipzig, 1838.

9. Giglioli, H. "On the Genus Callidina." *Quart. Journ. Micr. Sci.*, N.S., Vol. III., 1863, p. 237.

10. Glascott, Miss L. S. "Rotifera of Ireland." *Sci. Proc. Roy. Dublin Soc.*, N.S., Vol. VIII.

11. Hudson & Gosse. "The Rotifera." London, 1886.

12. Ibid. "The Rotifera." Supplement. London, 1889.

13. Janson, O. "Rotatorien-Familie der Philodinaeen." Marburg, 1893.

14. Joblot, L. "Descriptions et Usages de plusieurs nouveaux Microscopes." Paris, 1718.

15. Milne, W. "On the Defectiveness of the Eye-spot," etc. *Proc. Phil. Soc. Glasgow*, XVII., 1885–6.

16. Murray, J. "Some Rotifera of the Sikkim Himalaya." *Journ. Roy. Micro. Soc.*, Dec. 1906, p. 641.

17. Pritchard, A. "The Natural History of Animalcules." London, 1834.

18. Weber, E. F. "Faune Rotatorienne du Bassin du Léman." *Rev. suisse de Zool.*, t. 5, 1898.

19. Western, G. "Philodina macrostyla and Rotifer citrinus." *Journ. Quekett Micr. Club*, ser. 2, Vol IV., p. 87.

Explanation of Plates.

The figures of the complete animals which I have been able

to draw from nature are all drawn to one scale, so that relative sizes may be compared. The two species, *macrostyla* and *aculeata*, do, however, vary greatly in size. The figures copied from Gosse, Pritchard, and Janson, and the details of parts, are not drawn to scale, but are made of any convenient size.

Plate 15.

1. *P. aculeata*, commonest Scottish form.
2. *P. macrostyla*, type, feeding.
3. *P. tuberculata* (Gosse) feeding.
4. ,, ,, section of trunk, with plates.
5. *P. spinosa* (Bryce) dorsal view, feeding.
6. ,, ,, ventral view, partly contracted.
7. *P. macrostyla*, lateral view of antenna.

Plate 16.

8. *P. aculeata*, var. *crystallina*, var. nov.
9. The same, ventral view, contracted.
10. *P. macrostyla*, jaws.
11. *P. aculeata*, with eight hemispherical knobs.
12. ,, ,, with eight spines and two knobs.
13. ,, ,, with eight short, thick spines.
14. ,, ,, lateral view of the same form.

Plate 17.

15. *P. macrostyla*, type, creeping.
16. *P. aculeata*, var. *medio-aculeata*, lateral view.
17. ,, ,, ,, ,, dorsal view.
18. *P. tuberculata*, section of neck.
19. *P. macrostyla*, rostrum with its various processes.
20. ,, ,, lateral view of rostrum.
21. *P. aculeata*, after Gosse.
22. ,, ,, after Pritchard and Ehrenberg.
23. ,, ,, with ten spines, no lateral.
24. *P. macrostyla*, lateral view of foot.
25. ,, ,, ventral view of foot.
26. *P. aculeata*, var. *medio-aculeata*, after Janson.

SOME HAIRS UPON THE PROBOSCIS OF THE BLOW-FLY.

By Edward M. Nelson, F.R.M.S.

Read December 20th, 1907.

It has been truly said that the proboscis of the Blow-fly is one of the most interesting of microscopical objects, and, like the Podura scales, it has already been examined by such an army of observers that it is scarcely possible for us nowadays to discover anything that has not been seen a hundred times before. At the time I began to be interested in the microscope, the Blow-fly's tongue, squeezed flat, as mounted by Topping, was a common test for low-power objectives, the test being the sharpness of the "Zebra marks" at the root of the cut suctorial pipes.* I suggested that the minute spinous hairs upon the upper surface of the sucker would make a more suitable test, and they have since been largely used for that purpose. These spinous hairs are very interesting, inasmuch as they admirably illustrate nature's adaptation of a means to an end. It is neccessary that the upper surface of this very delicate membrane should be protected while the insect is feeding, and it is also necessary that the means of protection should neither overload the membrane nor interfere with its pliability. Nature, however, has found a way out of the difficulty. She has studded the membrane with quantities of very small spinous hairs. These hairs are so minute as not to impair the flexibility of the membrane, either when expanded and in use, or when flaccid and withdrawn; at the same time, being curved, they form a better protective covering than they would if they were straight.

The visibility of the filamentous ends of these hairs is not only a test, but affords excellent practice in minute microscopical work, which one should undertake before attempting the more difficult examination of the flagella of bacteria. It was stated above that these hairs were spinous; there are, however, other hairs equally minute upon the rostrum which are of a totally different character, being pliant and soft. Besides these minute

* Illustrated by W. T. Suffolk, *M. M. J.*, vol. i. 1869, pl. 16, fig. 2.

hairs there are others, which, in comparison, might be called giant hairs, for at the base they are five times thicker than the others are long. One measures ·063 in length and ·002 in breadth, while a minute hair measures ·00044 in length and ·000036 in breadth. These giant hairs, which are found both upon the rostrum and upon the maxillary palpi, are ribbed longitudinally, and a few of them have filamentous endings.

In addition to these three kinds of hairs, there is a fourth kind, ranged round the edge of the suctorial disc. These hairs are about forty times as long as the minute hairs, and ten times as broad. They are tubular, with a flat flange on either side. They work on the same principle as the tongue itself, which is admirably described by our past President, Mr. Lowne, in his monograph on the Blow-fly, vol. i. p. 139. "The proboscis," writes Mr. Lowne, "is an erectile organ. It is flaccid and folded on itself when not in use, but is capable of being rendered rigid by the injection of air into the extensive tracheal sacs which lie in its cavities. When the proboscis is in use, it is projected from the head capsule, and rendered stiff by the injection of air into its trachea. Its varied movements are brought about by the action of muscles; the flaccid proboscis is also folded and withdrawn into the head capsule by means of retractor muscles."

The same supply of air which inflates the tongue also erects these hairs. The object of this is twofold: first, it renders them stiff enough to afford special protection to the delicate edge of the suctorial disc, and, secondly, when the tongue is relaxed they become flaccid and in no way interfere with the folding up of the organ into the head capsule. One of these tubular hairs measured ·0187 in length and ·00036 in breadth. All the measurements are in fractions of an inch.

My attention was first directed to these tubular hairs by noticing that they were all blunt-ended, and in marked contrast with the others, which had filamentous terminations; from this I was led to investigate their true character. In conclusion, Mr. Merlin, who kindly undertook to examine these hairs, states that his view entirely agrees with mine.

ON HYMENOLEPIS FRAGILIS.

By T. B. Rosseter, F.R.M.S.

(*Read January* 17*th*, 1908.)

Plate 18.

Taenia fragilis, n. sp., Krabbe, 1867.
Hymenolepis fragilis, Rosseter, 1906.

In the year 1867 Krabbe took this tape-worm from the intestine of the Teal (*Anas crecca*, Linn.), commensal with *T. malleus*; and in his *Bidrag til Kundskab*, No. 57, p. 300, Pl. 7, figs. 158–160, describes it thus:

Long. 40 mm.; lat. 1·3 mm.
Uncinulorum 8, corona simplex quorum, long. 0·056–·059 mm.
Aperturae genitalium secundae.
Long. penis 0·13 mm.; lat. 0·004 mm.
Habitaculum *Anas crecca*, in insula Foehr (Krabbe).

I took this tape-worm from the intestine of a Wild Duck (*Anas boschas, fera*, Linn.), and this is the only recorded instance of its having been found since Krabbe discovered the species and gave it the name of *Taenia fragilis*.

Some difficulty is experienced, so far as the hooks of the rostellum are concerned, in defining and determining the species of either this tape-worm or that of Rudolphi's *T. fasciata*, as in each instance the rostellum bears a crown of eight sickle-shaped hooks. I have a few young specimens of *T. fasciata* with scolex bearing eight hooks taken from *Anas boschas*, *dom.*, fed by me with cysticeroids of the same. To a critical eye the hook of *T. fasciata* (Pl. 18, Fig. 14) is more deeply curved than that of *H. fragilis* (Fig. 13), whilst the root of *H. fragilis* is more thickened at its proximal end than that of *T. fasciata*, and is also somewhat hooked at its distal end. Then, again, if a single male or hermaphroditic segment of *H. fragilis* were taken from the faecal matter it would require a previous knowledge of the strobila of *T. sinuosa* to discriminate accurately that the segment was not a proglottis of the latter species, because *H. fragilis* has a spinous bulb in the same locality of the proglottis as that of *T. sinuosa*.

Personally I am placed in this position. Amongst my numerous

specimens I have not a perfect worm, that is to say, I have not one that possesses a scolex with the rostellum and eight hooks, and only two specimens whose terminal proglottides have developed into uterine segments bearing the hexacanth or six-hooked brood. Yet the strobila, taken as a whole, is so unlike that of *T. fasciata*, *T. gracilis*, or *T. octacantha* with eight hooks, or *T. sinuosa* with its spinous bulb, and the male generative organs of the above-mentioned species are so dissimilar from my specimens that, in spite of its being minus the hooks, I have no hesitation in determining my species of tape-worm as Krabbe's *Taenia fragilis*. The largest specimen I possess measures seven millimetres less than Krabbe's; but then mine are minus the scolex and neck. The evolution of the strobila and the varied formation of the segments is shown in Fig. 1, Secs. 1–10.

The male genital pore (Fig. 1, Sec. 10, M.G.P.) is a simple circular opening in the dorso-anterior portion of the segment on the lateral margin of the same. There are three testes (Sec. 10, Fig. 2), one situated proximally on the posterior margin of the segment, and the other two distally in the vertical plane, the one being superimposed upon the other; the efferent ducts of the latter form a junction immediately on leaving the gland. The efferent duct of the proximal testis runs distally, meets and makes a junction with the ducts of the distal testes, and thus forms the vas-deferens (Fig. 2). It still continues its course distally for a short distance, then sharply curves, or swings round, and enters the bursa, where it becomes the vas-deferens interior. The testes have a diameter of 0·062 mm.

That portion of the male genitalia which in the majority of other known species of tape-worm whose organs of reproduction have been studied has received the name of cirrus-pouch, is, in this instance, a composite sac, and is situated in the dorso-anterior-dextral portion of the segment. This sac comprises the prostate gland, the vas-deferens interior, the vesicula-seminalis, with its coiled vasa-efferentia, and the cirrus, with its sheath and pouch. Thus, as I have said above, it is a composite sac containing, with the exception of the testes, the whole of the male organs of generation, and I purpose denominating it in this instance the "bursa genitalium." It is 0·445–0·455 mm. long, and through the median axis 0·097 mm. in diameter (Fig. 3).

Dr. v. Linstow, to whom I am indebted for much kindness, in his work on *Taenia ursina*, n. sp., taken from the Brown Bear (*Ursus arctos*), *Taenia davainae struthionis* Houttoyn (camel), and *Taenia serpentulous* Schranck, from *Corvus corona* (*Archiv für mikroscop. Anatomie*, Band 42), in all three instances felt compelled, in describing the male genital organs, to depart from the beaten track, and to call the sac which under different circumstances would have been the *cirrus-pouch*, the *expulsion-blase*, because the bladder itself was distinct from the cirrus. Although the cirrus, with the coiled vas-deferens and prostate gland, lies within the "expulsion-blase," yet in neither species did the "expulsion-blase" contain, nor, according to the researches of von Linstow, did the cestode itself possess a vesicula-seminalis, the coiled vasdeferens fulfilling the function of the organ.

In the case of *H. fragilis* it is so different, because the creature possesses a seminal vesicle with a coiled vasa-efferentia, and the cirrus, with its sheath and pouch, is totally distinct from and independent of the bursa, and this latter does not fulfil the functions of a contractile "expulsion-blase" or bladder; neither, as far as my observations lead me to a conclusion, does the cirrus-pouch in this instance fulfil such an office, as it is independent of the seminal vesicle; but the latter organ, having been filled to repletion with spermatozoa from the testes, pressure is brought to bear through the swollen coiled efferent ducts, forcing up the funnel-shaped base of the cirrus, and consequently the sheath to which the elevator-muscles at the anterior or invaginated end of the pouch are attached. This causes the cirrus to protrude, the coiled vasa-efferentia to lengthen itself out, the sperm to flow up through the ducts of the cirrus coition ensues, and a prolapsus of the vesicle naturally follows.

The prostate gland (Fig. 4) is claviform. It is covered dorsally, proximally, and partially distally by the vesicula-seminalis. At its proximal end it bifurcates, each duct of the bifurcation elongating and attaching itself to the proximal end of the cirrus-sheath.

The vas-deferens interior (Fig. 3, V.D.I.) enters the bursa at its distal end, runs upwards nearly the whole length of the bursa; its proximal end dilates into the form of a reservoir (Fig. 3, R); it then curves, and, descending, forms the vesicula-seminalis.

The vesicula-seminalis (Fig. 3, V.S.) is a long sac 0·27 mm. long with a mean width of 0·045 mm. Its narrowed distal end terminates in a coiled efferent duct, which attaches itself in a ligamentary form to the cirrus. It is early filled with spermatozoa from the testes, on the completion of which they (the testes) become absorbed. The head of the spermatozoon (Fig. 12), when fully developed and ready for transmission, is spatulate, with a slight constriction in its centre. Its plastic contents could not be differentiated, as they were unaffected by staining, haematoxylin and safranine being the stains employed.

The cirrus (Figs. 3, 5, 6) is a long, smooth, hollow rod. At its distal end, where the vas-efferentia attaches itself, it tapers to a fine point, with a circular orifice. The sheath of the cirrus (Fig. 5, C.S.) is a continuation of the vasa-efferentia. At the distal end of the cirrus, a short distance up, by the aid of a $\frac{1}{16}$-in. objective one finds that the sheath at its base or commencement is thrown into a series of wrinkles or bands, as if to give it a firmer attachment to the cirrus; also that the cirrus is attached to the sheath by very fine muscular fibres, evidently retractor muscles, because, when the cirrus is retracted or at rest within its sheath, these fibres hang loosely in a spiral form within the sheath. At its proximal end the sheath becomes spinous or hispid.

The cirrus-pouch (Fig. 5, C.P.) is a circular tube involuted more or less at its proximal and distal ends, caused by the protrusion or retraction of the cirrus-sheath, because when the cirrus is everted for the purpose of coition the sheath is partially everted with it, being, as is seen in Fig. 5, a telescopic arrangement. The pouch does not run the whole length of the sheath, but is an offshoot midway from the latter.

Just below the male genital pore is the spinous bulb (Fig. 7), which is characteristic of this species of tape-worm, and also of *T. sinuosa*, the only two known Avian tape-worms whose cuticle bears such an organ.

The female genital organs call for but little comment. The female genital pore (Fig. 1, Sec. 9) is situated posterior to the male on the ventral side. The pore is an insignificant jagged cleft. The vagina is cup-shaped; the vaginal canal runs sinuously obliquely to the anterior border of the segment in the median line; it then curves, runs proximally again for a short distance; again curves distally, and forms the receptaculum-seminis.

The receptaculum-seminis (Fig. 1, Sec. 9, R.S., and Fig. 8) lies anterior to the bursa on the ventral side. It is an oval sac 0·169 mm. by 0·105 mm. Its fructifying canal descends and forms a junction with the ovarian ducts, also with the ducts of the shell- and yelk-glands. The shell-gland is oval and the yelk-gland is elongated, the former being superimposed on the latter in the middle of the proglottis between the ovaries (Fig. 1, Sec. 9, S. and Y.G.). The ovaries are paired, and are situated proximally and distally in the segment (Sec. 9, P.O. and D.O.).

Krabbe, in his *Bidrag til Kundskab*, pp. 300–301, No. 57, in the last paragraph of his description (external) of this species of Avian tape-worm says: "*I de bageste Led fandtes hos nogle af Ormene umodne rundagtige Æg.*" To me, from this statement, it is evident that Krabbe's specimens, like the majority of mine, were ovarian, and not uterine specimens: that is to say, the proglottides contained ovarian eggs, because he explicitly says that the eggs were unripe (*umodne*), meaning that they had not developed into the hexacanth or six-hooked brood stage.

The ovarian egg (Figs. 9*a* and 9*b*) when passed down the ovarian duct for fertilisation is circular, and it possesses but one soft albuminous envelope or membrane. When fertilisation of the ovarian eggs commences, the organs of generation are then gradually absorbed and obliterated, and the segment becomes a common uterine sac. On rupturing an early uterine proglottis, eggs were found in various stages of development or segmentation, and in some of the more recently impregnated eggs the long tail of the spermatozoon could be detected protruding itself from the egg-membranes. When the parent cell is evolved, by cleavage and the development of the embryonic hooks, into the hexacanth stage, it then possesses two distinct membranes, an external and an internal envelope, and for a time continues to be circular. But as the formative substance segmentates and becomes bell-shaped, with a hollow or gastrula cavity, the outer membrane of the egg then becomes ovular, and continues to be so, for of this shape I find it in older or ripe uterine segments, and in this form undoubtedly it is passed on to its nurse—an Ostracod or a Copepod—for development into a cysticercoid. The circular uterine egg has a diameter of 0·031 mm., the space between the outer and inner membrane being 0·002 mm. The diameter of the

embryo is ·021 mm. The oval egg is 0·04 mm. in its long axis, and has an equatorial diameter of 0·02 mm. The embryonic hook is 0·003 mm. long. The hook is longer than the root, which in this instance is abnormal.

Explanation of Plate 18.

Fig. 1. Sections of strobila, Nos. 1–10, Nos. 1–4 × 70, Nos. 5–8 × 35, Nos. 9, 10 × 35. The last two sections are hermaphroditic segments showing position of female and male generative organs. Sec. 9, ventral. Sec. 10, dorsal. V., vagina; V.C., vaginal canal; R.S., receptaculum-seminis; P.O., D.O., proximal and distal ovaries; S. and Y.G., shell- and yelk-gland; M.G.P., male genital pore; P.T., D.T., proximal and distal testes; B.G., bursa-genitalium.

" 2. Testes with their efferent ducts and vas-deferens; *e.d.*, efferent ducts; *v.d.*, vas-deferens exterior × 70.

" 3. Seminal vesicle filled with spermatozoa dissected from bursa-genitalium; *v.d.i.*, vas-deferens interior; R., reservoir of same; V.S., vesicula-seminalis; *c.v.e.*, coiled vasa-efferentia; *c.*, cirrus divested of its pouch and sheath × 155.

" 4. Prostate gland × 155.

" 5. Anterior portion of cirrus-pouch, C.P.; C., protruded cirrus; C.S., its sheath.

" 6. Posterior portion of pouch.

" 7. Spinous bulb from cuticle. Fig. 7*a*. Ring-collar of same divested of spines × 155.

" 8. Female organs. V., vagina; V.C., vaginal canal; R.S., receptaculum-seminis; *f.c.*, efferent fructifying canal × 155.

" 9. (*a*) Ovarian eggs; (*b*) early stage of same × 350.

" 10. Uterine egg, or six-hooked brood × 350.

" 11. One of the six embryonic hooks; *a-b*, anterior; *b-c*, posterior × 1,400.

" 12. Spermatozoon with spatulate head—diagrammatic.

" 13. Hook from scolex of *Taenia fragilis*, after Krabbe × 920.

" 14. Hook from scolex of *Taenia fasciata*, after Krabbe × 920.

THE MALE GENITALIA OF THE COCKROACH, *PERIPLANETA ORIENTALIS*, LINN., AND THEIR HOMOLOGY WITH THE GENITALIA IN DIPTERA.

By W. Wesché. F.R.M.S.

(*Read January 17th*, 1908.)

Plates 19 and 20.

The sexual armature of the male of *Periplaneta* has every part present (or its homologue) that is found in the most elaborate combination in the Muscidae, but it is extraordinarily difficult to understand and homologise, as every piece is asymmetrical. In many species of the Orthoptera, fertilisation is brought about by the male transferring a spermatophore to the cloaca of the female; Dr. Benjamin Lowne thinks that this is most probably the method by which the cockroach is impregnated.* Certainly there are no signs of an ejaculatory duct in the penis, though the other parts are highly organised, and it can be seen that the elaborate apparatus found in other insects for storing and controlling the flow of spermatozoa, is represented by an equally, or even more elaborate apparatus for storing and protecting the spermatophore. Bearing in mind the great probability of Dr. Lowne's suggestion, not only as coming from so high an authority on insect anatomy, but supported by the details of the structure, we may conjecture that the genitalia of this order of insects are not (unlike the mouth parts) of archaic type, but are a specialisation, which has resulted in the complete transformation of the mechanism of the whole organ, and of the functions of its parts, the ejaculatory duct changing its course and opening in the centre under the part whict I call the cover (Pl. 20, Fig. 6), while a special gland is present, opening between the paraphalli, which has functions probably connected with the formation of the spermatophore. I shall show later that the palpi usually present

* *The Anatomy, Physiology, etc., of the Blow-fly*, p. 664 (1895).

in the interior of the genitalia are aborted, but there are a number of sensory hairs which indicate the site of the left palpus, while the right has completely disappeared. This remnant indicates by its presence that in some period of the evolution the palpi were fully developed, and that changes have taken place. The functional changes undergone by these parts are, very possibly, the cause of their extraordinary asymmetry; similar conditions are found in *Periplaneta americana*, Linn., and a species of *Mantis* as shown in the descriptions of Mons. A Peytoureau.*

The exterior parts are less difficult to recognise, as they are symmetrical, but they are very dissimilar from their homologues in other insects, and quite archaic in type, as may be seen by a comparison with the Crustacean Oniscidae (wood-lice).

I shall now describe each portion of the armature separately, with the nomenclature that has been formulated for the corresponding parts in Diptera †; though this is an inversion of the usual process, yet, as I have endeavoured to show, it is advisable, owing to the exigencies of the case.

(*a*) *Forcipes inferiores.*—These are represented by a symmetrical pair of simple unsegmented rods with blunt points, inserted in sockets and placed laterally on the ventral side of the abdomen (Fig. 5).

(*b*) *Forcipes superiores.*—These I homologise with the cerci; a symmetrical pair of palpi-like organs with sixteen joints and moderate pubescence, which is more marked on one side than on the other. Some delicate sense-hairs can be seen scattered among the more robust tactile-hairs. One of my preparations exhibits a complicated series of nerves and ganglia, showing that the part fulfils sensory functions, as these organs often do in the Diptera (Fig. 4).

(*c*) *Lamina superior.*—A highly chitinised plate which covers the bases of the *forcipes superiores* corresponds with this.

* *Morphologie de l'armure génital des insectes*, A. Peytoureau. Paris, 1895.

† The Genitalia of both Sexes in Diptera. W. Wesché, *Trans. Linn. Soc.* London. 2nd. *Ser. Zool.* vol. ix., Part 10, 1906.

(*d*) *The extremity of the penis.*—In most insects this part is membranous, and is pierced by the orifice of the ejaculatory duct. Here there is no duct, and its usual place is closed by a membrane covered with very short cilia, forming a fur or delicate tomentum; where this cover ceases, the membrane is more chitinous, and has a marking of minute scale-like sculpturing of the chitin, 140 to the mm. The whole part fits into the theca (Figs. 1, 2, d).

(*e*) *The theca or penis sheath.*—This part in the flies does not reach to the end of the ejaculatory duct, and it not only forms a support to the *hypophallus*, but also to the appendages which surround it—the *spinus*, the *palpi*, and the *forcipes interiores*. In *Periplaneta*, however, it supports the *hypophallus* and the *spinus*; it is separated from the platforms from which spring the *forcipes*, and its extremity is elongated into a cowl-like head, covering the membrane of the ejaculatory duct (Figs. 1, 2, e).

(*f*) *The paraphalli.*—There are two asymmetric rods with pointed ends which are in similar positions to these organs in the Muscidae. They are the "saddle-shaped piece" of Professor Miall, and between the forks is the opening of his "conglobate gland." * The paraphallus on the left of the penis is furcate, and has a minute roughening of its surface, similar to that found on the membrane at the extremity of the penis (Fig. 3).

(*g*) *The hypophallus.*—This is represented by a thoroughly characteristic piece, highly chitinised and covered with aculeations. It is a plate, bent round so as to nearly form a tube, and it is connected with the theca by hyaline membranes. The structure is quite similar to that found in Lowne's "bulb" and "hypophallus" in the Blow-fly (Fig. 2 g).

(*h*) *Spinus titillatorius.*—This organ in *Periplaneta* has been regarded as the type, and from it is derived the name as applied to other insects. Being the single unpaired organ, it is the key to the homology. It is a long, highly chitinised tube, with a transverse arm at the extremity, the arm having a small aculeation on the underside. At its base is a piece which seems

* *The Cockroach*, Miall & Denny, p. 174, 1886.

to be an articulation (Figs. 1, 2, v, and 7). Membranes connect the *spinus* with the *theca* and *hypophallus*, and enclose this piece (Figs. 1, 2, h).

If we indulge our imagination, we can form a mental image of some annulated, worm-like creature, low in organisation, scarcely, if at all, higher than a colony of polyps; each annulation complete in itself, with alimentary canal, genital pore, and some form of rudimentary appendages. The genital pore, as we have found in the majority of creatures, would be on the side opposite the oral aperture. That being so, at one end of this compound worm would be a mouth and at the other a pore. These, from their favourable situations, monopolised the work, and the others atrophying from disuse, or, if part of the alimentary canal, joining on to the mouth of the next segment, evolved into a worm which was compound only in the number of its appendages and annulations, and would be rather lower in the scale of life than *Peripatus*. From this we can see why the ovaries and testes of insects are always found at the posterior end. It also explains in some measure the anomalous genitalia of the male dragon-fly (Odonata).

To continue our phantasy, in the course of ages, one or more sets of the appendages were used at both extremities, either to grasp food or to hold a partner in coitus. Slowly and by degrees modifications in the appendages, which were of advantage to the parent, were transmitted to the offspring and became established, until finally the appendages of a number of segments were brought into use and were changed into hooks, blades, and feeling-organs, grouped round the mouth at one end and the pore at the other. A fold of skin in the median line was also modified, either into a hook or a protection of the important apertures. These folds are now represented by the single unpaired organs which are found both in the mouth and the genitalia. In the former it is the *lingua*, in the latter the *spinus titillatorius*. Such is the theory which has been put forward to explain how the com-

plications at the extremities of an insect have been produced by gradual changes in the more simple appendages.

(*i*) *Forcipes interiores.*—These are represented by two unsymmetrical pieces, the one on the left having the point twisted round like a corkscrew, the other furcate; their upper ends connect by means of a hyaline membrane, while their bases join with a complicated structure, consisting of a number of plates and membranes, with extremely elaborate muscular attachments, which form the containing apparatus of the spermatophore. This portion of the containing apparatus seems homologous with that part of the theca which in the Muscidae supports the *titillator*, *forcipes interiores*, and the *palpi genitalium*. This view is strengthened by the situation of the remnant of the palpus.

(*k*) *Palpi genitalium.*—The organs are aborted, but the site is marked on the left side, on a piece which is soldered to the left forceps, by a number of sensory hairs. Comparing it with remnants of palpi in other parts and in other insects, I have no hesitation in identifying this. The absence of a similar vestige on the right side is accounted for by the situation of the "cover" (Fig. 6), which would quite shut off this side from any function.

(*m*) *The great apodemes.*—I have found on each side of the theca two small islands of chitin, surrounded by a sea of hyaline membrane. They appear to be without any function, and are nearly suboval plates tapering to points. From their structure and from their position, I consider these as the atrophied remains of the apodemes, whose function is so important and whose presence is so constant in most insects. Their disuse has been brought about by the changes already discussed (Figs. 1, 2, m).

(*o*) *Sacculus ejaculatorius.*—This organ in the Muscidae is membranous, but in the Tipulidae it has a chitinous structure, and suggests that it has its counterpart in the very complicated

series of pieces which form the containing apparatus; besides the part at the base of the left forceps which carries the remnant of the palpus, and which is homologised as part of the theca, there is a convoluted plate below (Fig. 9), a cover which is very prominent on the right side (Fig. 6), a plate which forms an upper part (Fig. 12), and a dome-shaped piece (Fig. 11) which contains an articulation to the convoluted plate (Fig. 13). These parts form connections to those attached to the forceps; they do not readily separate when dissected out, and are apt to break and consequently difficult to study.

The convolute plate has some part of the surface roughened with minute scale markings; a similar structure has been noted on the left *paraphallus* and on the part that represents the orifice of the penis. This suggests itself to me as a surface to which a semi-viscid body would cling, yet not stick, probably regions of contact with the spermatophore.

(*p*) *Ejaculatory apodeme.*—This is a shield-shaped piece with a strong chitinous process running down the middle for the attachment of muscles; it is situated in the centre, and appears to work the cover. From its structure and situation I feel fairly sure of the homology of this part, and it is consequently a useful guide (Fig. 10).

Interior organs.—These are comparatively simple, and are amply explained in Professor Miall's and Mr. Denny's excellent monograph (already quoted), and in the late Professor Huxley's work on the Invertebrata,* to which I refer those who wish to study these parts.

Conclusion.—It remains to say that regarding the whole organ as a piece of mechanism, it may be divided into four parts; (1) a tube for the passage of spermatozoa into the containing apparatus, and a gland (Prof. Miall's conglobate) for the production of some semi-viscid fluid, used in the formation of the spermatophore; (2) the combination of the theca and hypophallus, penis, and paraphalli, bending over to place the orifice of the

* *The Anatomy of the Invertebrated Animals*, T. H. Huxley, 1877.

conglobate gland in contact with the containing apparatus, so mixing the secretion from the gland and the spermatozoa, and forming a spermatophore. This necessary movement of the theca has led to its detachment from its surroundings, already discussed in section (*e*). (3) The containing apparatus with the covering plate held down over it by the apodeme. On excitement the lever would relax the muscles holding down the cover, and (4) the spinus bending over would transfix a spermatophore, and transfer it to the cloaca of the female. Dr. Lowne quotes Cornelius,* "who gives a description of the sexual act in this insect, and describes it as being accomplished with great rapidity." A fact quite consistent with the explanation of the mechanism offered above.

Explanation of Plates 19 and 20.

The size of the drawings on Plate 20 has been regulated by convenience. Their true relative magnitudes are shown on Plate 19.

The following letters are used in the plates :

d. The extremity of the penis.
e. Theca.
f. Paraphalli.
g. Hypophallus.
h. Spinus titillatorius.
i. Forcipes interiores.
k. Palpus genitalium.
m. Great apodeme.
o. Sacculus ejaculatorius.
p. Ejaculatory apodeme.
r. Convoluted plate.
s. Cover.
v. Articulating piece.

Fig. 1. The genitalia removed from the cavity of the abdomen, showing the natural arrangement of the parts, with the muscular structure as seen from the right.

* *Blow-fly*, p. 634.

Fig. 2. The same preparation, seen from the left.

Fig. 3. The paraphalli dissected out from the surrounding parts.

Fig. 4. Forceps superior.

Fig. 5. Forceps inferior.

Fig. 6. Cover of the containing apparatus.

Fig. 7. Articulating piece at the base of the spinus titillatorius.

Fig. 8. The forcipes interiores and the site of the atrophied palpus; (*a*) "corkscrew" forceps, (*b*) furcate forceps, (*c*) site of atrophied palpus, (*d*) portion of containing apparatus—part of theca.

Fig. 9. Convoluted plate, part of containing apparatus.

Fig. 10. Ejaculatory apodeme; in this insect working the containing apparatus.

Fig. 11. Dome-shaped piece (part of containing apparatus); (*a*) articulating piece to convoluted plate.

Fig. 12. Upper piece, containing apparatus.

Fig. 13. Articulating piece from interior of dome-shaped piece, enlarged.

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GNIFICATIONS.

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pronounced. Substituting monobromide of naphthalin (1·658), the differentiating power is again increased, whilst by employing realgar the microscopist has a still greater accession of possibilities. It is evident, then, that this arsenical compound is by far the best medium in which to mount diatoms, and it is a subject of regret that more diatom-mounters do not take advantage of its high index of refraction notwithstanding the many difficulties attending its use. The photomicrographer, however, should always recollect, if he has a special diatom to photograph, to do his best to obtain it mounted in this medium, as it is far easier to get good results than if it is mounted in any other. Unfortunately, however, it frequently happens that one is unable to obtain a realgar mount of some rare species, or to remount a particularly fine specimen which is already put up in some

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Fig. 3. The paraphalli parts.

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Fig. 5. Forceps inferior

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Fig. 8. The forcipes int palpus; (*a*) "corkscrew" atrophied palpus, (*d*) po of theca.

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Fig. 12. Upper piece, coı

Fig. 13. Articulating pie(enlarged.

PRESIDENT'S ADDRESS.

THE PHOTOGRAPHY OF VERY TRANSLUCENT DIATOMS AT HIGH MAGNIFICATIONS.

(*Delivered February 21st*, 1908.)

THE photography of very translucent diatoms at high magnifications is often quite a troublesome matter. In the first place, it is not easy to obtain sufficient contrast between the object and the background; and, in the second, it is often very difficult to show the secondary markings distinctly and crisply, especially when they require considerable magnification, as is almost always the case on account of their being so exceedingly minute.

The first of these difficulties is directly proportional to the nearness of the index of refraction of the mounting medium to that of the silex of the diatom. Taking the refractive index of the latter to be 1·43, and that of Canada balsam as 1·52, the "Index of Visibility"—as the difference has been somewhat dubiously called—is only 9, which is very small; hence troubles are at their maximum. With styrax by comparison, the difference of the indices produces some improvement in the possibility of discovering details, whilst contrast effects are more pronounced. Substituting monobromide of naphthalin (1·658), the differentiating power is again increased, whilst by employing realgar the microscopist has a still greater accession of possibilities. It is evident, then, that this arsenical compound is by far the best medium in which to mount diatoms, and it is a subject of regret that more diatom-mounters do not take advantage of its high index of refraction notwithstanding the many difficulties attending its use. The photomicrographer, however, should always recollect, if he has a special diatom to photograph, to do his best to obtain it mounted in this medium, as it is far easier to get good results than if it is mounted in any other. Unfortunately, however, it frequently happens that one is unable to obtain a realgar mount of some rare species, or to remount a particularly fine specimen which is already put up in some

other medium; and it is to assist those in this plight that the following hints have been written.

The first difficulty, as we have already pointed out, is that of getting sufficient contrast between the object and its background, but that is not, unfortunately, the only one with which we have to contend. It is by no means easy when high magnifications are employed to obtain really crisp photographs perfectly free from fog. The fault seems to be this: the small markings whether dots or pearls, may be perfectly well defined and perfectly crisp, but they appear as if they are mounted in fog. The appearance presented is often put down to over-exposure, but if a shorter one be tried no benefit accrues; the only change in appearance is that the photograph seems much fainter. To what then is this difficulty due? On not a few occasions the optician is blamed for omitting to carry his corrections sufficiently far, whilst the emulsion comes in for its share of abuse, the bogey of orthochromatism being brought in somehow or other. But in truth the trouble may not be caused by any of these supposed faults, but may be traced to optical difficulties, about which we shall now very briefly speak.

The laws of optics tell us that, owing to the finite wave-length of light, the image of a point cannot possibly be represented by any lens or combination of lenses as another point, but must be shown as a disc of more or less sensible diameter. Now this circle of confusion varies very largely with the magnification; hence, when great amplification obtains, this circle is correspondingly increased in diameter. Hence the dot or pearl appears not as a circumscribed dot, neat and crisply defined, but as one surrounded by what for our present purpose we may call "fog." It is easy to understand that the halo of fog around one dot joins up with the halo of its neighbouring dot, so that in the case of a row the whole series appear as floating in haze, the very appearance of which we have been complaining. Having ascertained the cause, what can we do to remove it? Seeing the optician can do nothing, save to tell us not to magnify so much—a proceeding we cannot avoid, because the objects are so exceedingly small—we should be at a loss to know what to do did not the photographer step in at this juncture to offer his assistance. Seeing that there may be many of our members who have not paid much attention to the scientific side of this subject, I must

ask your indulgence for a minute or two while I make a few preliminary remarks.

Speaking briefly, there are two kinds of emulsion used for coating photographic plates, the fast and the slow. Each has its own characteristics. The fast has the property of picking up and recording every little variation or "gradation" of light, as it is called, never failing to make such differences apparent. The consequent result of this property is that a photograph taken by such an emulsion would not fail to show the fog surrounding the dots to perfection. With the slow type it is just the contrary. Its power of differentiation, or of dealing with very small gradations of light coming from an object, is sensibly less than is the case with the fast plate, so, in consequence, it would certainly not show the fuzzy haze nearly so well as the fast emulsion. At once then you will say, Why not use such a plate? Unfortunately it must be at once stated that the very fact of the slowness of the sensitised film makes it impossible to do so, because the length of exposure would be prohibitive. But the photographer is not beaten yet; and I will now proceed to explain how he can assist the photomicrographer by the employment of his knowledge of the subject.

This is the method. The first negative being taken on a rapid plate, say at some thousands or more diameters, is developed preferably with hydrokinone to obtain as much contrast as possible. If it is a good one, showing the dots or other secondary markings sharply focussed, it is left to dry. When examined it will be seen to show the veil of which we are complaining, and perhaps such is well seen around the dots, so much so that it gives the appearance of their being immersed in a bath of fog. Perhaps the print may show this defect more definitely than the negative itself. A fast plate is then placed in contact (such a one as the "Flashlight" of the Imperial Company), and the printing frame is waved once before a sixteen-candle electric lamp, or some other powerful illuminant placed about two feet away. This is developed as if it were a negative, although, of course, it is a positive—by which is meant it is developed by time and not for the purpose so much of being used as an ordinary positive would be. It simply means that it is a very well exposed and developed positive and not a very thin and transparent one. The dots appear very plainly and sharply

focussed, but there is a decided fog all over the whole picture. This is specially noticeable between the dots, and serves to muddle them up in a very disappointing way. When dry, a copy of this is made upon a slow plate, such as a process or a lantern plate, and again developed by time. This becomes our second negative. Even a cursory glance shows at once how much brighter it is than the first taken direct from the object, but when the print or lantern slide is taken from this the improvement becomes very apparent. I may mention that to make the second negative on the slow plate an exposure of from 20 to 60 seconds is required when using the same light as before. I should also mention that the treatment explained is likewise of service in improving contrast, so that both the troubles of the photomicrographer are diminished by one and the same method.

In conclusion it should be remarked that the treatment suggested must not be considered a "faking" one: it is nothing of the sort, for it is merely a method of improving the result by photography instead of by changing the methods of the photomicrographer or seeking the aid of the optician, who admits he cannot help us.

There is great scope for individuality in applying this method. Some negatives require exactly the treatment mentioned, but others may not be improved unless all the copying is done with slow emulsion, for the fogging may be difficult to get rid of; whilst even yet another type may not require quite slow plates, being copied throughout by an emulsion which we may call a "medium one." The effect of "overdoing" the method is that the dots appear quite dried up and far too much reduced in diameter, whilst "underdoing" is shown by the process not quite removing the fog. Actual experiment may be required to determine the best means.

NOTE ON *NAVICULA SMITHII* AND *N. CRABRO.*

By A. A. C. Eliot Merlin, F.R.M.S.

(*Read October 18th*, 1907.)

While pleasantly occupied in examining the new and interesting work on microscopy dedicated to our Club by its President, my attention was attracted by the striking photograph of *Navicula Smithii* (Plate X.), and the description annexed thereto aroused my curiosity, and led me to hunt through my cabinet in search of a specimen.

Two valves, apparently exactly answering in shape and general appearance to the species depicted in Plate IX. fig. 12 of Van Heurck's Atlas of the Diatomaceae, but measuring ·15 mm. in length in place of ·1 mm., were found on a Thum styrax circle slide of forms from the Gulf of Naples. One of these happens to be mounted so that the concave interior is exposed to view, while the other exhibits the outer convex surface.

On examining both under an apochromat of N.A. 1·42, I was surprised to find that the oblique double rows of "pearls" described by Van Heurck (p. 91) as most essentially typical of the species, appeared well defined on the specimen mounted inside out, while the exterior convex surface of the other valve clearly showed oblique double rows of closely adjacent, very distinct primaries, capped and pierced with conspicuous secondary perforations. These secondaries, proving perfectly easy and obvious under critical illumination with my Leitz long tube $\frac{1}{12}$-in. semi-apochromat of N.A. 1·32, should consequently be within the grasp of any decently good, cheap, homogeneous immersion objective. Focussing down from the secondaries, it also proved easy to see the lower orifices of the primaries in "black dot" focus; these appeared sharp in outline, contracted, well separated, and

arranged in oblique double rows, precisely like the "pearls" shown in the photograph taken by our President. I should here clearly state, however, that the form photographed seems to be the rarer and much smaller elliptical species also mentioned by Van Heurck, and shown in Plate B, fig. 23 of the Supplement to his work. I have not examined this variety, and its minute structure is not necessarily identical with that of the large kind in my collection.

It must also be pointed out that all the species described by Van Heurck are apparently Belgian forms, and, besides being smaller, may not be exactly similar in construction, or at least more elusive and difficult, than the Naples specimens; but even should it prove that all possess analogous perforated caps crowning the primaries, it only shows how easily omissions may arise in the interpretation of detail, the exact nature of which has been supposititiously elucidated by high authorities presumably employing objectives of exceptional excellence, and points to the absolute necessity for rigidly critical and careful methods of research, in order to arrive at a true conception of the ultimate structure of minute objects so far as our present optical appliances will allow.

I would strongly recommend any one interested in the subject to obtain a good strewn slide of the various varieties of *Navicula Smithii*, mounted in styrax, and to examine it with a properly corrected and adjusted $\frac{1}{12}$-in. oil-immersion objective, the full cone of a dry aplanatic condenser, and Gifford's screen. A light form of stand may prove sufficient in this case for the coarser examples, although for really difficult faint diatomic images I have found the Powell No. 1 to be absolutely necessary.

Addendum to Note on *Navicula Smithii.*

Since writing the above a small valve, measuring about ·07 mm.

in length, has been found on the Thum Naples circle slide, apparently identical in size and form with the specimen depicted by Van Heurck, Plate B, fig. 23. It is mounted inside out, and shows the distinctive diagonal double rows of "pearls" well, while focussing down through these to the under (really the outer) surface, the secondary perforated structure can be indistinctly but unmistakably seen. That it should be visible at all through the entire thickness of the valve proves that it cannot be difficult, even in this small form, when properly viewed from the upper side. It is therefore now quite certain that both large and small examples of *N. Smithii* from the Gulf of Naples have the primaries crowned with a very beautiful kind of secondary structure, which should assuredly be within the reach of any good oil-immersion lens capable of standing a large working aperture. There is no question whatever of any exceptional keenness of vision being required in this instance, and I feel convinced that many members of a Club such as ours must be provided with an optical outfit quite sufficient for the purpose. In good specimens of the larger kinds, a $\frac{1}{4}$-in. Powell objective of N.A. ·72, made in 1850, has been lately found to show the secondaries with critical axial illumination, while the aprochromatic $\frac{1}{8}$-in. of N.A. 1·42 exhibits them on a valve measuring only about ·04 mm. in length.

Navicula crabro Ehr. (*N. pandura*, Bréb.).

Further observations show that the *N. crabro*, a form analogous to, although differently shaped from *N. Smithii*, and possessing, like the latter, a double row of "pearls," also exhibits an exactly similar secondary structure. When the primaries are in high "white dot" focus each is found to be composed of a group of minute white points, but with a lower (and truer) focus these clearly appear as the "black dot" images of perforations

piercing the capped "pearls." The specimens examined are also from the Gulf of Naples, some showing the composite structure well, while in other equally large forms the primaries are so small that the secondaries cannot be properly resolved, although one can see that they are there. The *N. crabro* is figured in Van Heurck's Atlas of the Diatomaceae, Plate IX. fig. 1, and a description of it is given on page 89 of the text. Only the two rows of "pearls" are mentioned as its distinguishing feature, the minuter secondaries having evidently escaped notice, as in the case of *N. Smithii*, unless, indeed, it should prove that the Belgian varieties of both species are very different in their ultimate structure from those obtained in the Mediterranean, although similar in other respects.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on October 18th, 1907, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on June 21st were read and confirmed.

Messrs. L. Gunn, R. L. Mestayer, W. H. Coldwells, and Prof. E. A. Minchin were balloted for and duly elected members of the Club.

Numerous additions to the Library were announced, including a copy of *Microscopy* by Dr. E. J. Spitta, presented by the author.

Mr. Karop, rising to thank the President, on behalf of the Club, said: "Gentlemen, as the list of donations includes a work the author of which is our esteemed President, it would be obviously embarrassing for him to propose a comprehensive vote of thanks to the respective donors, and therefore I am privileged to do so on his behalf. Moreover, the book itself is dedicated to us as a Club, and although we know very well that we include several members, whom I need not name, who are competent exponents of physical optics as applied to the microscope, yet collectively I am afraid we have much to learn; and here is a text, addressed pointedly to us, on which we may safely rely to remove some of our difficulties and guide us along the right path. Further, I am informed, on the highest authority, that the work has already attained a very large sale for one of its class. I have, then, very great pleasure in moving a very hearty vote of thanks to Dr. Spitta for his donation and dedication."

Mr. W. R. Traviss exhibited and described a pair of aquarium forcep scissors, a very ingenious little piece of apparatus designed for retaining a hold on a piece of weed, etc., in an aquarium while cutting it, so that it does not fall to the bottom and get possibly lost "in the usual way." He also described two other pieces of apparatus, both designed for a similar purpose,

but for use in narrow-necked bottles or test-tubes, or in other instances where the scissors could not be used.

The construction of the forcep scissors may be readily understood from the following short description as given by the inventor.

The edge of one blade of the scissors is ground at right angles to the cutting surface (Fig. 1). At the point P on the other blade is firmly fixed, at the broad end only, a steel spring made square at the farther end. This spring projects beyond the cutting edge of the blade when the scissors are open. The object shown (sectional diagram) is first held as the scissors are closing, and is cut off when they are finally closed, being retained until released by the reopening of the blades.

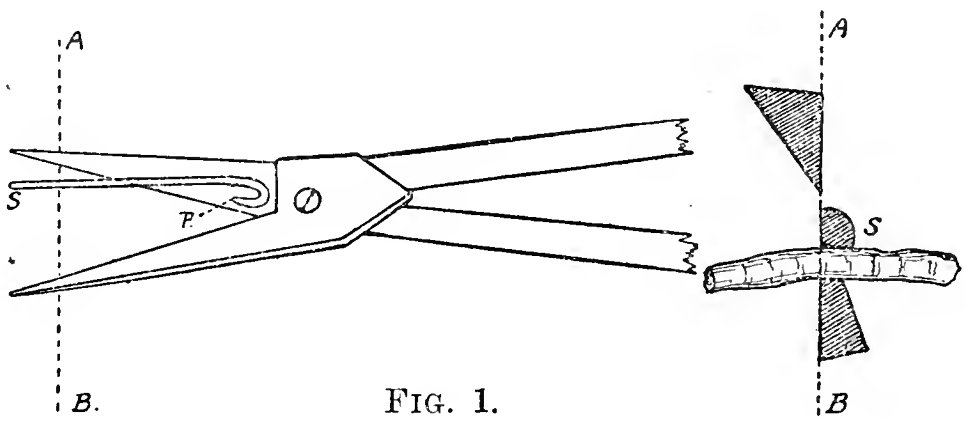


FIG. 1.

Mr. C. F. Rousselet, F.R.M.S., said he thought the pieces apparatus described would be very useful. Curiously enough, that very evening Mr. C. Lees Curties, of Messrs. Baker's, had handed to him yet another little instrument—a pair of cutting forceps—also designed to hold a cut piece of weed in a somewhat similar manner.

Mr. H. Taverner, F.R.M.S., exhibited a number of stereo-photomicrographs of water-mites done by the Sanger-Shepherd three-colour transparency process in the manner he had described at a former meeting of the Club. The photographs now before the meeting were all taken with a $1\frac{1}{2}$-in. objective, with a diaphragm behind having a circular aperture of 2 mm. A separation between centres of 2 mm. was employed to obtain the stereoscopic pair.

The Hon. Secretary said he regretted to have to announce the death, on September 27th last, of Professor Chas. Stewart, LL.D. Aberdeen, F.R.S., etc. Professor Stewart joined the

Club in 1877, and for some time held office as a vice-president.

The Hon. Secretary read a note communicated by Mr. E. M. Nelson, F.R.M.S., on "A New Semi-Apochromatic $\frac{1}{6}$." The writer asked to be allowed to bring to the notice of the Club a new form of objective, computed by Mr. A. E. Conrady, F.R.M.S., and made by Messrs. Watson & Sons. It is a semi-apochromatic $\frac{1}{6}$, of N.A. 0·74. The point of novelty about the lens is the very great working distance it possesses—viz., 1 mm. An examination of this lens showed that its initial power was 60, and that its aperture was correctly stated. Its performance upon the usual test objects was highly satisfactory, which proved that not only was the objective well corrected, but that it also had its lenses truly centred. Various biological objects were examined, including sections of animal and vegetable tissues, entomological preparations, and geological and mineral substances, all of which were brilliantly shown. Bacteria were then examined under very deep eyepieces, and the images given by the lens were not in the least broken down. The flagella of the tubercle bacillus were seen. The image, naturally, was a difficult one, but not exceptionally so. As to the working distance of the lens, it focussed an object through a slip ·064 in. thick. An objective such as this cannot but be useful to many of the members of this Club, who are so well known for their critical examination of pond life, where a long working distance is a *sine quâ non.*

The President said that he should not have made any remark upon this objective had not Mr. Nelson brought the matter forward; but as he had had the privilege of seeing and testing it when in its workshop mount, he felt he might add his testimony to its excellence. Mr. Nelson had not mentioned its behaviour with the Abbe test-plate; but he might add that the correction of the outer zone, so difficult to deal with, was decidedly an advance. He could honestly endorse every remark made by Mr. Nelson, and, in point of fact, he was quite unable to break down the image. Its aperture was sufficient for all practical purposes, and its working distance was 1 mm., as stated. He felt that he must be allowed to congratulate Mr. Conrady on his computations, and Messrs. Watson & Sons on their manufacture of the combination.

Mr. C. D. Soar, F.R.M.S., read a paper on "Three Water-Mites New to Britain," communicated by Mr. G. P. Deeley.

The Hon. Secretary read "A Note on *Navicula Smithii*," communicated by Mr. A. A. C. Eliot Merlin, F.R.M.S.

The Hon. Secretary said that Mr. Nelson had sent a note on this subject, quite agreeing with Mr. Merlin, and stating that the description of the "secondaries" was quite what he (Mr. Nelson) would have written. The Hon. Secretary went on to say that he had personally examined a slide of this species from the Van Heurck collection, belonging to the Club, but had not succeeded in really seeing the "secondaries." He could say there was something there, but it was much too minute to say anything as to its character.

The President said that the varying visibility of these markings was no doubt due to actual variation of the fineness of the markings in different specimens, and instanced *A. pellucida* as an example of a species of which it was very difficult to obtain a really good specimen to show the "dots."

The Hon. Editor (Mr. F. P. Smith) gave a short account of a valuable paper on "Pseudoscorpions, British and Foreign," communicated by Mr. Edv. Ellingsen, of Kragerö, Norway.

Mr. H. Wallis Kew said that the paper was really a report by Mr. Ellingsen on British pseudoscorpions. The specimens were sent to him in order to find out if the names we used had the same significance as those employed on the Continent.

At the meeting of the Club held on November 15th, 1907, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., in the Chair, the minutes of the meeting held on October 18th were read and confirmed. Messrs. W. Gray, W. E. Zehetmeyer, F. G. Dell, A. W. Oke, C. C. Lindsay, L. D. Sayers, W. C. Bradford, and Capt. A. C. Kerans were balloted for and duly elected members of the Club.

The President drew the attention of members present to the fact that the meeting was honoured by the presence of one of their honorary members. He referred to Mr. F. H. Wenham, C.E., the inventor of the well-known Wenham prism for binocular microscopes, and of many other useful and wonderful appliances. He hoped that Mr. Wenham would come many more times, and was sure that the Club would give him a very

hearty welcome. This the meeting accorded, and Mr. Wenham duly acknowledged.

With reference to the paper by Mr. A. A. C. Eliot Merlin on *Navicula Smithii* read at the last meeting, the Hon. Secretary showed by a blackboard drawing the arrangement of the fine structure which Mr. Merlin had discovered. This, in his opinion, illustrated in a most perfect and complete manner the well-known views of Mr. Nelson as to the development of diatom structure.

Mr. D. J. Scourfield, F.Z.S., F.R.M.S., gave a short account of a valuable paper on "*Philodina macrostyla*, Ehr., and its Allies," communicated by Mr. James Murray. The genus Philodina was founded by Ehrenberg in 1830. His order Zygotrocha, including all Rotifers having the ciliary wreath divided into two parts, contains an illoricated family, Philodineae, which corresponds in the main with the order Bdelloida, as now understood. The presence of eye-spots, formerly held to be critical, is not now insisted on, and Mr. Murray redefines the genus as "Genus Philodina.—Toes, four; eyes, cervical or none." Mr. Scourfield then proceeded to refer to the changes, which are very few, which this definition will make in the *personnel* of the genus. He also mentioned that Mr. Bryce quite agreed with the alteration. The genus now includes some twenty-six admitted species, of which sixteen have eye-spots. As these species may be conveniently arranged in five groups, it was suggested that further investigation might prove the generic definition still too wide. Mr. Scourfield instanced Cyclops, with its twenty-five or more British species, as a similar case, and said that unless the genus was broken up into groups it was almost impossible to satisfactorily comprehend it. Mr. Murray's paper proceeded to deal with the characteristics of the five groups proposed.

Mr. D. Bryce, after some appreciative remarks on the paper, said that as long ago as 1886 Mr. Milne, of Glasgow, said that the eye-spots could no longer be considered as a critical point in the classification of the Bdelloid Rotifers. He also referred to the chief differences between the genera Rotifer and Philodina. As contrasted with the sixteen species described by Hudson and Gosse, Mr. Bryce said he knew at least a hundred, and there were perhaps fifty more known to other investigators.

Mr. C. F. Rousselet, F.R.M.S., said that Mr. Murray dealt almost entirely with specimens from mosses. The moss was simply dried, when the animal would secrete a drop of jelly around itself, and could so remain alive for a long time. Mr. Murray had examined mosses from very many parts of the world.

Mr. W. Wesché, F.R.M.S., said he regretted that the easy method—easy, that is, for beginners—of classification according to eye-spots was to be done away with. The number of toes is so very much more difficult to observe.

Mr. F. P. Smith (Hon. Editor) made some remarks introducing his paper on "British Spiders taken in 1907," which dealt with some twenty species, including the addition of one species to the British list.

At the meeting of the Club held on December 20th, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., in the Chair, the minutes of the meeting held on November 15th were read and confirmed.

Messrs. F. Holmes, F. F. Beckett, M. P. Swift, B. Evans, A. S. Potter, and J. E. Pratt were balloted for and duly elected members of the Club.

The President drew attention to the exhibition then before the meeting of a number of interesting sections of injected tissues prepared by Mr. E. J. Sheppard.

In acknowledging the vote of thanks passed to him, Mr. Sheppard drew special attention to the injected and stained sections of the tongue, bladder, and gall-bladder of the guinea-pig.

Mr. J. I. Pigg, F.R.M.S., exhibited in the lantern an interesting series of photomicrographs of the development of the maidenhair fern from the spore to the prothallus, and also the different stages in the production and growth of sporangia and the scattering of the spores.

The Hon. Secretary read a paper, communicated by Mr. E. M. Nelson, F.R.M.S., entitled "Some Hairs upon the Proboscis of the Blow-fly."

Mr. W. Wesché thought that probably all the fine hairs on the probosces of all flies are taste organs. They are usually at the end of each of the tracheae, so that whatever is sucked up

by the proboscis passes over these hairs, and communicates the sensation of taste. He thought that the larger hairs were tactile organs.

Mr. E. F. Law exhibited a number of extremely interesting lantern-slides. These were photomicrographs, taken on the Lumière autochrome plates, of the brilliant oxidisation colours caused by heat-tinting on polished surfaces of various commercial copper and iron alloys. Mr. Law said, in the course of his remarks, that this heat-tinting is used as a means of distinguishing the constituents of an alloy. The tints are obtained by the heating of a highly polished surface until it begins to oxidise. To prevent further oxidisation, it is suddenly cooled by plunging it into mercury. The different constituents of an alloy oxidise at different rates, and each gives a different colour. The magnifications employed were × 100 and × 1,000 diameters, and were obtained by the use of a Zeiss vertical photomicrographic apparatus with prism illuminator. With the illuminant used, a powerful arc, the average exposure was half a minute for 1,000 diameters, and a very little less for the lower magnification. The small difference is to be referred to the employment, in the one case, of an oil-immersion objective.

In moving a vote of thanks, the President made some very appreciatory remarks on the success which had attended the application by Mr. Law of the new processes of colour-photography to metallurgy.

FORTY-SECOND ANNUAL REPORT.

THE publication of the forty-second Annual Report enables your Committee to point to the maintenance of the Club's previous good position during the last twelve months.

During 1907 forty-eight new members were elected. This number, although smaller than that for 1906, which was phenomenal, is well in advance of the average for the period 1897–1906, which was 41·3. By resignation the Club loses twenty-eight members, and by death four members have been removed. This leaves a net gain of sixteen members; the total membership shown by the books on December 31st, 1907, being 451.

The attendance at both ordinary and informal meetings has been very good, the highest figure being 131 for the January meeting. Exhibits at the meetings have been interesting but not always too numerous, and your Committee has to reiterate the suggestion made last year that our "gossip" nights are opportunities for specialists to display objects which, though no novelty to those who study them, are quite otherwise to those who have not done so.

Among the communications received by the Club may be noted :

Jan.	*Hymenolepis nitida* and *H. nitidulans*	Mr. T. B. Rosseter.
Feb.	President's Address. A Review of Photomicrography	Dr. E. J. Spitta.
Mar.	On Water-bears (*Tardigrada*)	Mr. Jas. Murray.
,,	An Alona and a Pleuroxus new to Britain	Mr. D. J. Scourfield.
April.	The Collection and Preservation of Fresh-water Rhizopods	Dr. E. Penard.
May.	Recent Foraminifera of Victoria	Mr. F. Chapman.
June.	*Brachionus sericus*, n. sp.	Mr. C. F. Rousselet.
Oct.	Three Water-mites new to Britain	Mr. G. P. Deeley.
,,	A Note on *Navicula Smithii*	Mr. A. A. C. Eliot Merlin.

Oct.	Notes on Pseudoscorpions . .	Mr. E. Ellingsen.
Nov.	*Philodina macrostyla* and its Allies	Mr. Jas. Murray.
,,	Some British Spiders taken in 1907	Mr. F. P. Smith.
Dec.	On Some Hairs on the Proboscis of the Blow-fly . . .	Mr. E. M. Nelson.

The following lectures were also given:

Jan.	On the Nature of Living Organisms	Mr. A. E. Hilton.
Dec.	The Development of the Prothallus of the Fern . .	Mr. J. I. Pigg.
,,	Heat-tinted Sections of Metals .	Mr. E. F. Law.

Your Committee, in thanking the authors of these communications, notes with satisfaction the evidence of advance in microscopical science, and would point to such papers as Mr. Murray's on Water-bears and Dr. Penard's on the collection of Fresh-water Rhizopods as excellent introductions for those members who have not yet directed their attention to any particular group.

The series of demonstrations on the management of the microscope begun in 1906 was continued, and the thanks of the Club are due to Mr. C. Lees Curties, Mr. Conrad Beck, Mr. F. Watson Baker, Mr. H. F. Angus and their respective staffs for the great amount of thought and trouble these exhibitions must have involved.

Nine excursions were made during the year, with an average attendance of 19·5. The best attended was that to the Royal Botanic Gardens, when thirty-four members passed through the gates. The thanks of the Club are due to the Directors of the Royal Botanic Society, East London Waterworks, and the Surrey Commercial Docks, for allowing members to visit their grounds for the purpose of collecting.

The Library continues to be of the greatest use to borrowers, and is kept up to date by the addition of valuable gifts, purchases, and exchanges. These for the past twelve months have been as follows:

Ormerod (E. A.), *Observations on some Injurious Insects.* Given by Mr. R. T. Lewis.

Penard (Dr. E.), *Recherches biologiques sur deux Lieberkuhnia.* Given by the Author.

Spitta (Dr. E. J.), *Microscopy.* Given by the Author.

British Tunicata. Vol. 2.

Missouri Botanic Garden.

American Botanical Gazette.

Quarterly Journal of Microscopical Science.

Philippines Journal of Science.

Essex Naturalist.

Smithsonian Reports.

Proceedings, Memoirs, and Reports of the—

British Association,
Royal Microscopical Society,
Royal Institution of Cornwall,
Geologists' Association,
Bristol Naturalists' Society,
Literary and Philosophical Society of Liverpool,
Manchester Literary and Philosophical Society,
Natural History Society of Northumberland,
Manchester Microscopical Society,
Hertfordshire Natural History Society,
Optical Society,
Wisconsin Academy,
Academy of Natural Science of Philadelphia,

and various Reports and Pamphlets.

The demand for the loan of slides continues very great, and in the work entailed the Hon. Curator has had the able assistance of Mr. O. Whiting, whose recent death robs the Club of a most devoted and useful member. The number of slides added to the Cabinet in 1907 is 118, and includes some fine specimens of Tunicata. Dr. Penard has added to our obligation by completing a type collection of Fresh-water Rhizopods. The donations received have been as follows :

13 Marine Objects. Given by Mr. J. Rheinberg.
2 Pathological Preparations. Given by Mr. T. E. Burrell.
11 Physiological and Entomological. Given by Mr. C. Sidwell.
23 Fresh-water Rhizopods. Given by Dr. E. Penard.
40 Scale Insects, Mites, etc. from Natal. Given by Mr. R. T. Lewis.

Last year also we received:

A Binocular Microscope * from Miss Larmer,
One-inch and two-inch objectives from Messrs. W. Watson and Sons,
Expanding Stop from Mr. W. Traviss,
Set of Colour Screens from Messrs. Wrattan & Wainwright,
Copyright of twenty Stereo-Photomicrographs from Mr. H. Taverner.

The Club has enjoyed the advantage of seeing reports of its meetings within a week of their occurrence, a privilege owed to the courtesy of the Editor of *The English Mechanic*, to whom the thanks of the Club are due. To the Editor of *Knowledge*, also, we have to acknowledge the benefit of the publication of our proceedings in his journal. The work of writing these reports is in the hands of our Hon. Assistant Secretary, whose energies in this respect, and in the conduct of our meetings, are worthy of special mention.

Your Committee desires to thank the Officers for their services during the past year. In justice to these gentlemen, however, must be noted their contention that anything they are able to do can only be a proximate cause of the Club's well-being, and that ultimately the prosperity of the Club must depend upon the activities of its members generally. So long as this is recognised your Committee sees nothing to oppose the future progress of the Club.

* Acknowledged in Report for 1906.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB

For the year ending December 31st, 1907.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1906	240	4	0	By Rent	75	0	0
,, Subscriptions, Donations, and One Life Composition, £10, received during year	218	0	0	,, Expenses of Journal	139	4	10
				,, Postage	6	1	4
				,, Printing and Stationery	10	12	7
,, Dividends on Investments	12	15	0	,, Attendant	5	0	0
,, Sales of Journal	1	5	3	,, Petty Expenses	6	3	9
,, Sales of Catalogues, etc.	2	7	11	,, Commission, Advertisements	3	1	6
,, Receipts for Advertisements	21	0	0	,, Books, Slides, etc.	7	14	8
				,, Balance in hand	242	13	6
	£495	12	2		£495	12	2

INVESTMENTS.

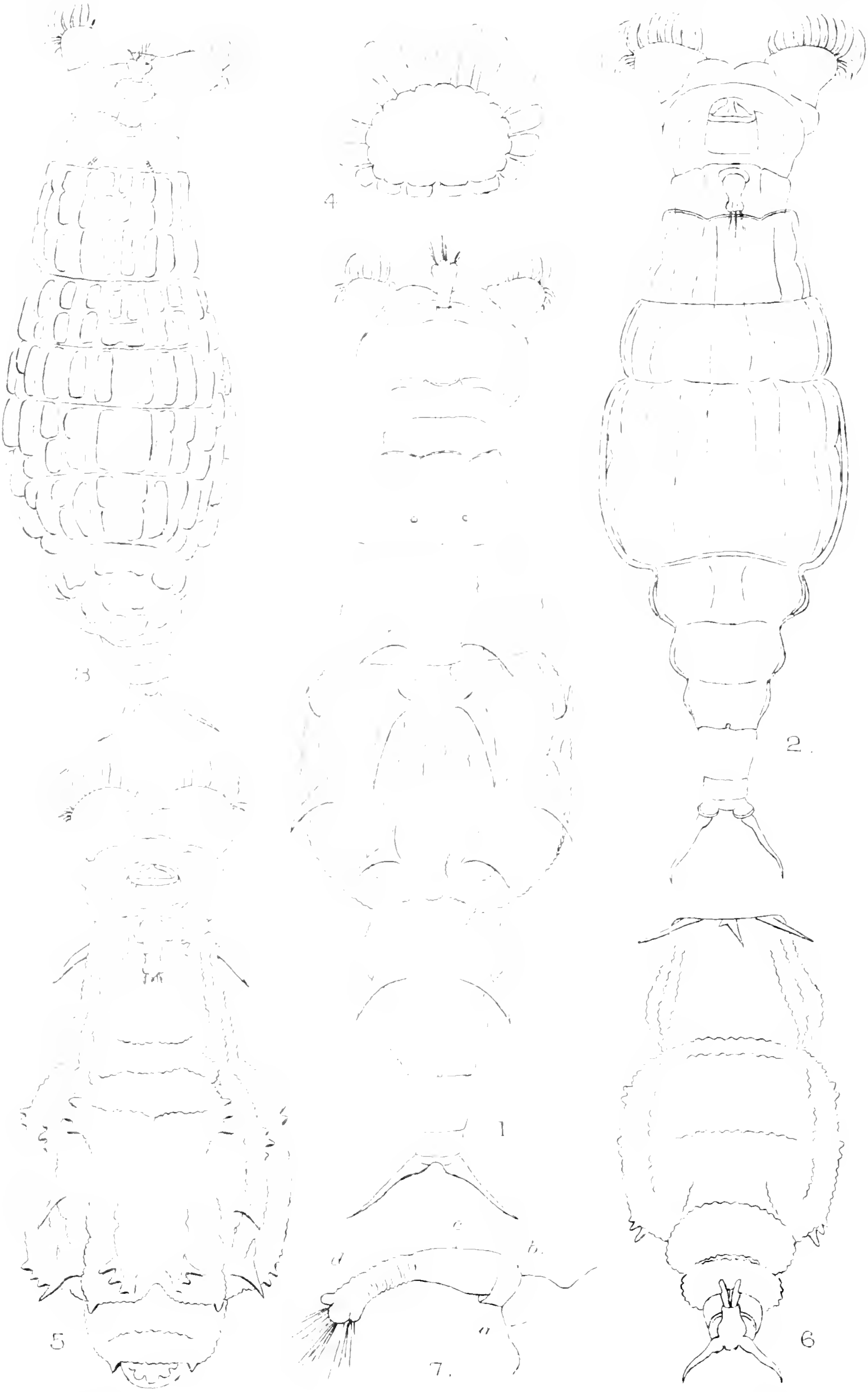
	£	s.	d.
$2\frac{1}{2}$ per cent. Consols	200	0	0
Metropolitan Water "B" Stock	100	0	0
Metropolitan $2\frac{1}{2}$ per cent. Stock	100	0	0
$2\frac{1}{2}$ per cent. Annuities, 1905	100	0	0

We have examined the above Statement of Income and Expenditure and compared the same with the Vouchers in the possession of the Treasurer, and have verified the Investments at the Bank of England, and find the same correct.

February 7th, 1908.

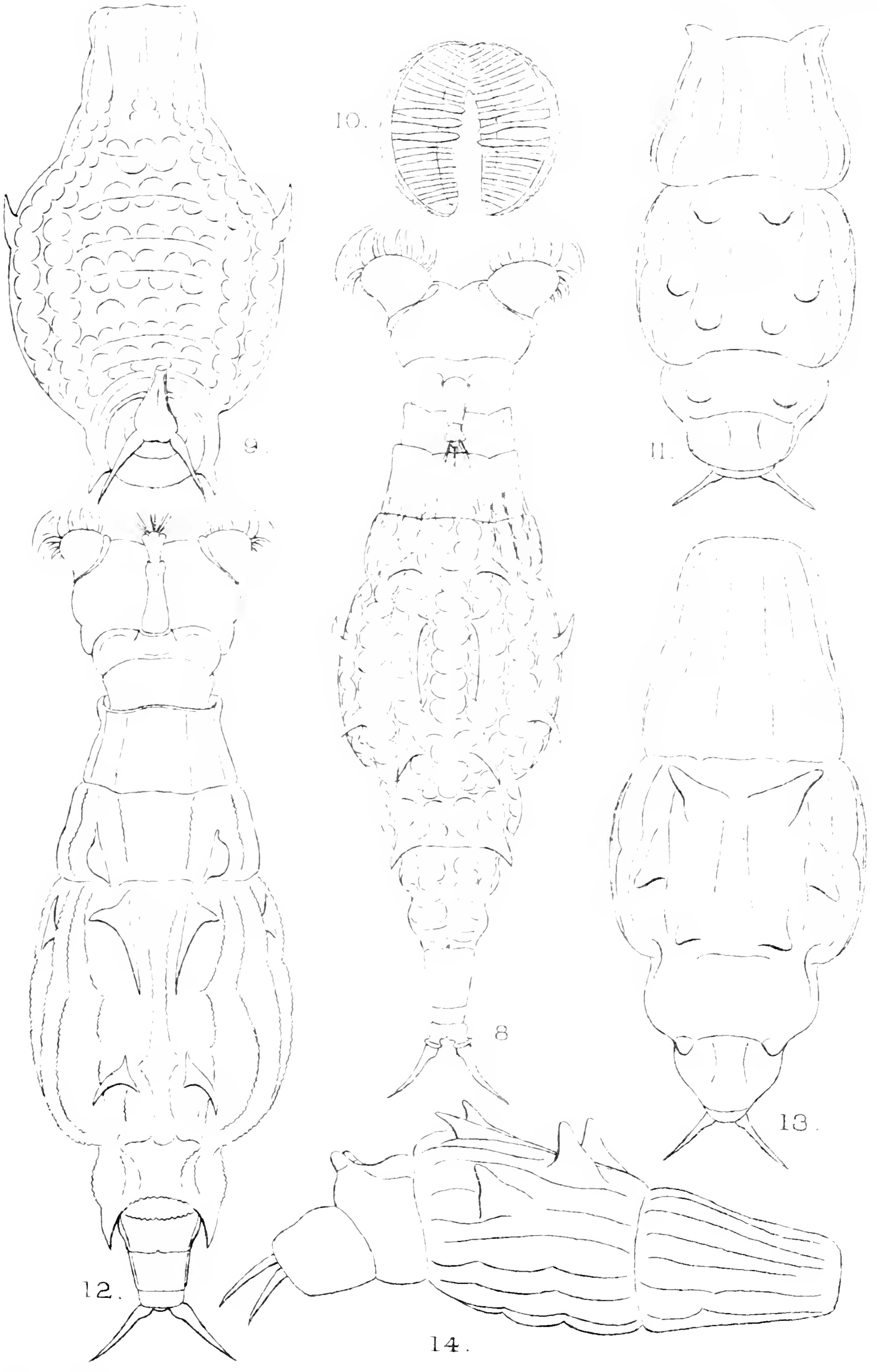
F. J. PERKS, *Hon. Treasurer.*

FRED HUGHES } *Auditors.*
A. E. HILTON }



A. H. Searle lith.

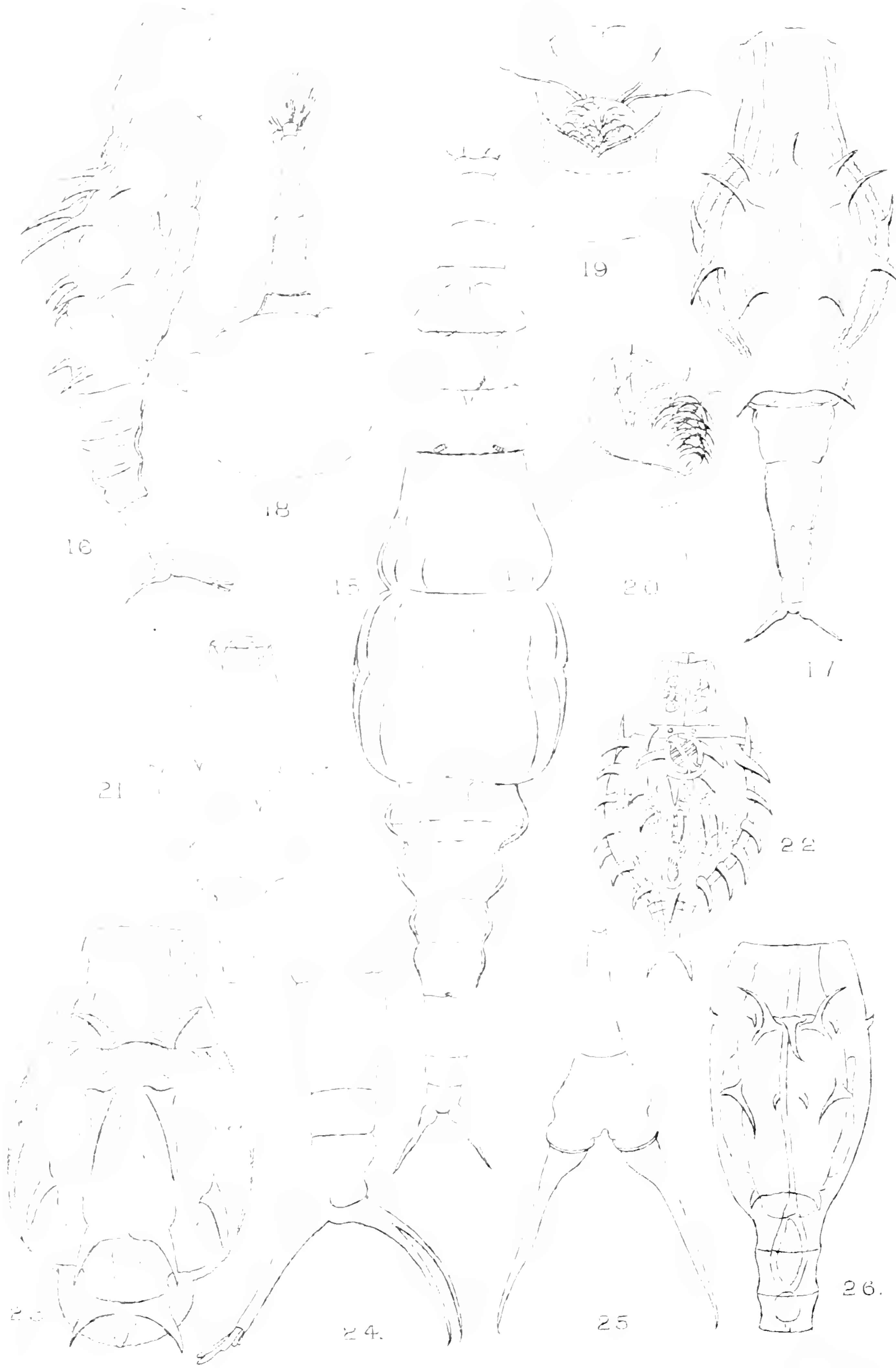
Philodinadae



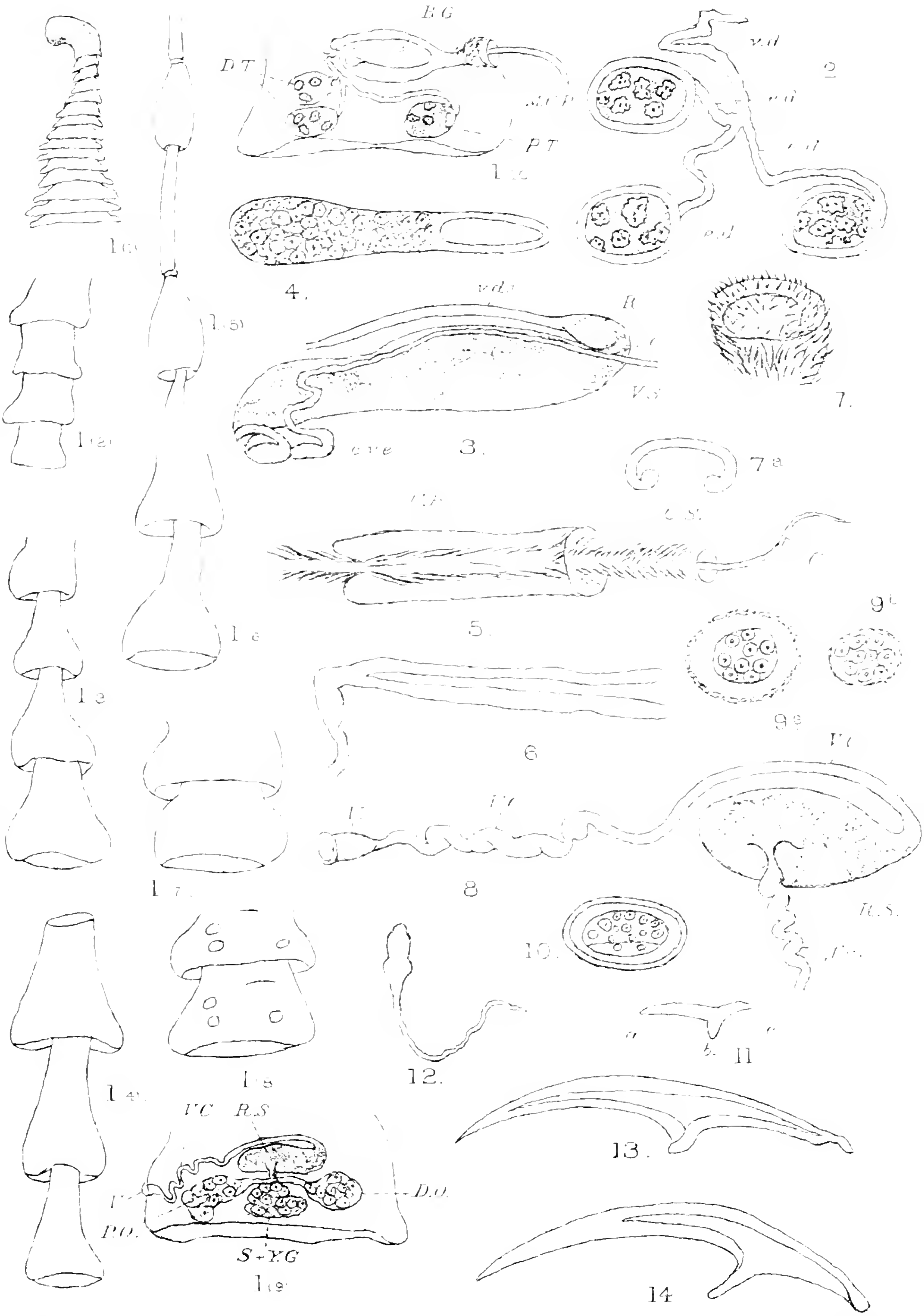
J. Murray del.

A. H. Searle

Philodinae.

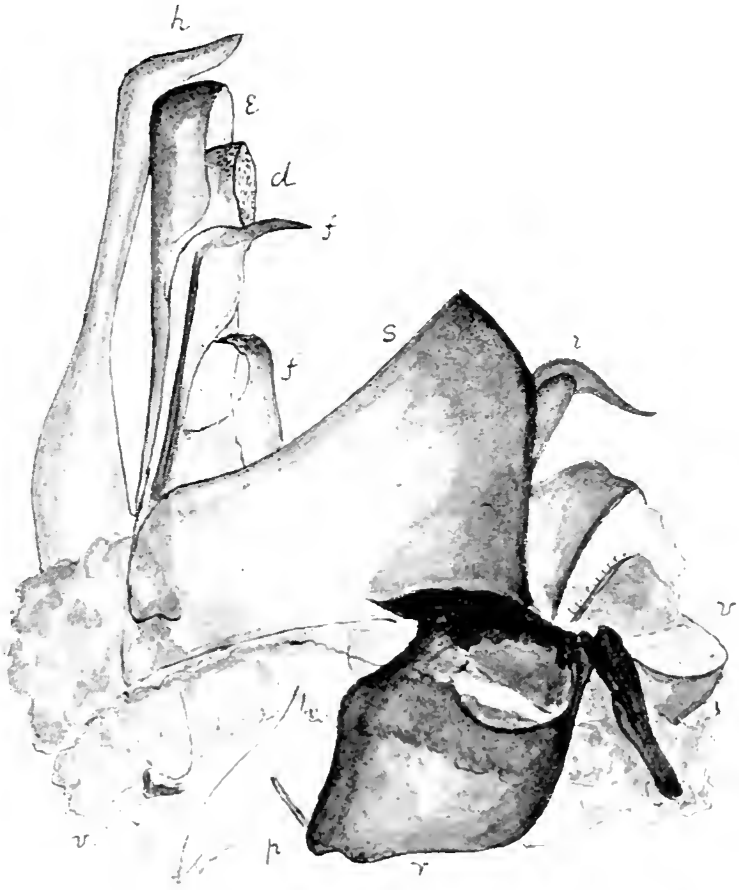


Philodinae



T.B. Rosseter del. ad nat. A.H. Searle lith.

Hymenolepis fragilis.



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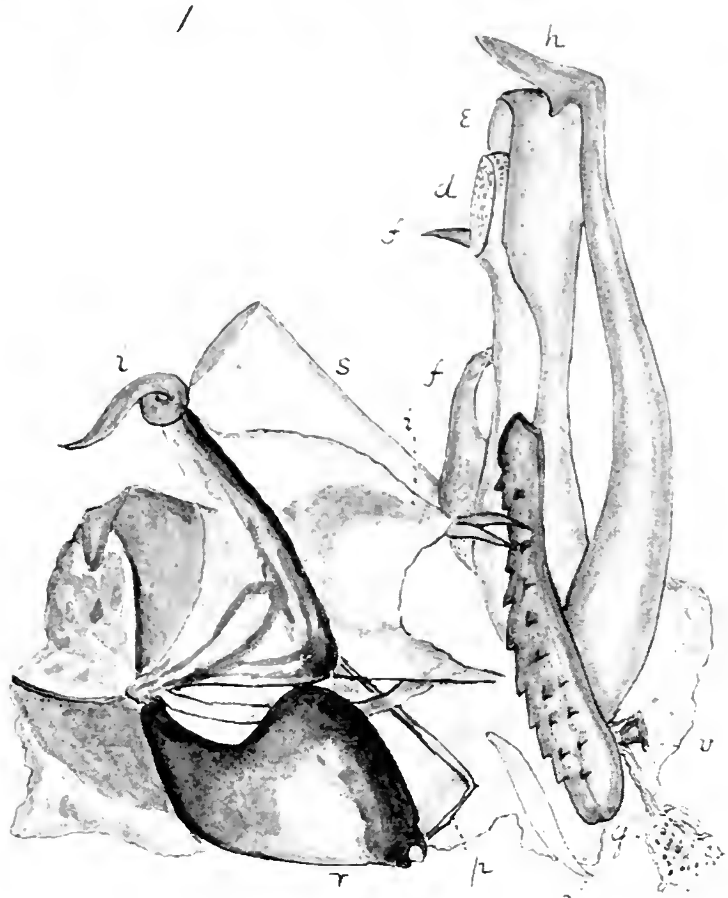

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W. Wesché, *ad nat. del.*

Genitalia of Cockroach.

W. Wesché, *ad nat. del.*

Genitalia of Cockroach.

ON THE CAUSE OF REVERSING CURRENTS IN THE PLASMODIA OF MYCETOZOA.

By A. E. Hilton.

(*Read March* 20*th*, 1908.)

The active plasmodium of a Mycetozoon is a naked aggregation of plasm, which has two characteristic movements: a streaming movement of the interior and more liquid plasm, as distinguished from the firmer exterior plasm; and an amœboid movement, by which the whole mass changes its form, and travels about. The two processes are so closely related that a description of the one necessarily involves allusions to the other; but they are sufficiently distinct for separate consideration, and the scope of this paper is limited to the cause of the streaming movements of the interior plasm.

Text-books on the Mycetozoa describe this phenomenon, but offer little explanation. In 1884 Professor de Bary, by whom the name Mycetozoa, "fungus-like animals," was first applied to the organisms previously called Myxomycetes, "slime-fungi," stated that "the internal causes of the change of shape, of the protrusion and withdrawal of processes, and the interior streaming of granules, were to a great extent unknown." Mr. Massee, in his monograph published in 1892, did not discuss the question. Mr. Lister's monograph, issued in 1894, mentioned that the cause of the rhythmic streaming of plasmodia had not then been ascertained; and as the Guide to the British Museum Collection, revised by him in 1905, describes the streaming, without offering any conjecture as to its origin, presumably no adequate explanation was forthcoming even at that recent date. In *Wonders of Life*, however, published in 1904, Haeckel stated that attempts had been made to explain the phenomenon on purely physical principles; and further that experiments by Ernest Stahl on *Aethalium septicum* had shown that the counter-movements in the Mycetozoa are provoked by a peculiar form

of pressure sensation, produced by the flow of liquids. These remarks, although suggestive, are not very illuminative; and I have not, as yet, met with anything more definite on the subject.

At this point it is advisable to notice that the problem before us is by no means the same as that presented by such phenomena as the circulation observable in the beaded hairs of the stamens of Spiderwort (*Tradescantia*), or the Cyclosis in certain water-plants, of which Nitella and Vallisneria are typical examples. In those instances, the movements continue in one direction. The reversing currents of plasmodia call for a different explanation; especially in view of the fact that there are reasons for regarding the Mycetozoa as of animal rather than vegetable nature.

In seeking the solution we desire, our task is simplified if we select for critical investigation a single representative species; and as I have had better opportunity of studying the plasmodium of *Badhamia utricularis* than of any other, the descriptions which follow are to be understood as referring to that species in particular; but while specific details vary, the main principles no doubt apply very generally to the whole group.

Viewed with the naked eye, or a pocket-lens, a healthy plasmodium of *B. utricularis* is seen to consist of a slimy substance, about the consistency of cream, orange-yellow in colour, but of no definite or permanent shape. The colour is simply due to absorbed materials, the digestible portions of which are in process of assimilation. The plasm itself, which in a pure state is almost transparent, is a complex substance, only able to carry on its activities while in a viscous condition; that is to say, in combination with water. Water does not dissolve plasm, and there is a limit to the quantity which plasm can imbibe; but owing to the loose molecular structure of the plasm, the absorption of water greatly relaxes it, and increases its mobility. On the other hand, if there is so much water that a plasmodium is swamped, and cannot get into contact with air, it becomes congested and moribund, as if suffocated, which is probably the case. The most suitable habitats, therefore, are the damp surfaces and furrows of rotting tree-stumps, bark, decaying leaves, mosses, and woody fungi, because these furnish not only food, but also a watery substratum on which the under parts of the

plasmodium can move freely, with its higher parts exposed to the atmosphere. Bearing in mind that plasm, owing to its peculiar molecular texture, is, in a high degree, both tenacious and elastic, it will be easily understood that the plasmodium, saturated by the moisture of the surface on which it rests, becomes relaxed and motile underneath, while the parts exposed to air remain more contracted. The contraction and relaxation are, of course, affected by every alteration in the temperature and humidity of the atmosphere.

Another point to be borne in mind is the fact, already alluded to, that the whole surface of the plasmodium, whether in contact with air or water, is somewhat firmer than the interior plasm. This surface plasm, called hyaloplasm, has no actual rigidity, nor is it membraneous or impervious, or clearly separable from the more fluid plasm beneath; but it is less mobile than the interior plasm, owing to conditions which govern surface tensions at the areas of contact of different media. As seen through the microscope, the hyaloplasm is a clear, transparent covering, unequal in thickness, merging imperceptibly into the interior plasm, and chiefly noticeable at the advancing margin of the plasmodium. Its function is important. By its firmer consistency, it preserves the integrity of the organism; while at the same time it yields to the impulses of the interior plasm sufficiently to allow the plasmodium to move freely from place to place. It is also probable that by its elasticity the hyaloplasm reacts physically upon the more fluid interior plasm; and this is possibly what Haeckel referred to when he mentioned that experiments had shown that counter-movements of Mycetozoa are provoked by a peculiar form of pressure sensation, produced by the flow of liquids; but if so, it is not a very clear way of stating the case.

Reverting to the plasmodium of *B. utricularis*, and surveying its general features, we notice that, whatever its shape may be, its substance is always distributed unequally. When feeding, it aggregates into irregular masses; but when foraging for food these become smaller, because shorter or longer extensions are protruded from them. These extensions, which at first have the appearance of pseudopodia, become very attenuated, spreading about in the form of a straggling network of larger and smaller veins, with few or many angular or rounded meshes. The

advancing extremities of the network are bordered with wavy or fanlike expansions, at the margin of which the plasm coming through the hyaline threads of the network collects in irregular ridges with constantly changing outline. We also observe in the creeping plasmodium that while plasm masses diminish in the parts towards the rear, new aggregations arise in more forward positions; the network acting both as channels for the fluid and flowing interior plasm, and a means of locomotion of the entire plasmodium, the veins being withdrawn from behind, while extending in the lines of advance. The significance of this unequal distribution into irregular and fluctuating masses, communicating by attenuated connections, will presently appear.

If the plasmodium has been cultivated for convenience on a flat piece of glass, and is viewed under the microscope by transmitted light, with a magnification of sixty to a hundred diameters, the sight presented is a striking one. The network veins, and other expansions of plasm sufficiently thinly spread to be semi-transparent, exhibit, in their interior, a rhythmic series of alternate flowing movements, made visible by more opaque granules carried along by the currents. The streaming commences slowly, accelerates until it rushes impetuously, slackens speed until it comes to a standstill, pauses as if hesitating, and then reverses its course. Each alternation occupies, on an average, about a minute and a half; but, as we should expect, the flow in the direction in which the plasmodium is creeping is rather longer and stronger than in the opposite direction.

This spectacle of streaming life-currents is singularly impressive. The oscillating rhythm of pause and rush is curiously fascinating, and in the mind of a thoughtful observer the question almost inevitably arises, "Why do not the opposing forces which alternately propel these currents counteract each other, instead of operating in turn, causing these remarkable reversals?"

When the problem is stated in that simple way, we see at once that the solution we seek must of necessity be a physical one, leading up to a physiological one; because although the phenomenon is, in the first place, obviously physical, it is certain, action and reaction being equal and opposite, that physics cannot furnish the full explanation. What, then, are the physical facts, and the physiological solution they suggest?

My answer to this is, that a patient examination, under a microscope, of a plasmodium of *B. utricularis* leads to discoveries which, for the sake of brevity, may be formulated thus:

(*a*) The streaming movements in the finer threads of the network are controlled by the stronger currents in the coarser veins.

(*b*) The main currents in the principal veins, in their alternations, always radiate from, and converge towards, more or less definite centres consisting of larger or smaller aggregations of plasm. For example, a fanlike expansion receives its impulses from the mass with which it is connected, and from which it protrudes. The general direction of the streams is from the base to the advancing border; and from the border to the base when the current is reversed.

(*c*) If a fanlike extension is severed from its base, at what we may call the isthmus of attachment to the plasm mass which feeds it, the impulse controlling the circulation is temporarily lost. The streaming instantly diminishes, and what is left is disorganised; the remaining streamlets being feeble, disconnected, and out of harmony. On the other hand, if a piece is cut from the margin of the fan, the base of attachment being left intact, the circulation in the fan is but little affected.

(*d*) In the excised portion of a plasmodium recovery of circulation may come about by the denser portion of its mass becoming dominant, and controlling from this fresh centre a new system of currents spreading through the more extended parts.

(*e*) If two plasmodia of the same species, or, which is the same thing, if two separated portions of one plasmodium, come into contact and coalesce, the separate systems of circulation at first conflict, but gradually combine into a circulation common to the whole, as either one or other of the two main centres of impulse gains predominance.

(*f*) Contrariwise, it sometimes happens that in a single plasmodium more than one mass controls the streaming movements, each exercising an influence over a certain area, but unable to control the rest; and unless harmony be re-established this results in severance at the limits of control, the one plasmodium becoming two or more, by reason of each head-centre commanding a certain following of the extended plasm.

(*g*) A very small plasmodium, or, which is the same thing again, a very small piece cut from a larger plasmodium, is capable of exhibiting streaming movements; but the plasm actually streaming is always less than the mass of which it forms part. A certain relative proportion has evidently to be maintained, because an excised portion exhibits streaming only in places, although before excision its whole area may have been in a streaming condition.

All this clearly points to the conclusion that the streaming of the interior plasm, liquefied by the damp substratum on which the plasmodium moves, is controlled by drier aggregations of plasm in contact with the atmosphere; and that these controlling centres affect the fluid plasm by an alternating force of pressure and suction; the pressure propelling the streaming plasm towards the extremities through the elastic extensions of hyaloplasm, and the suction drawing it back again through the same channels; the hyaloplasm keeping the flowing plasm intact, but at the same time yielding, in amœboid fashion, to its impulses. That pressure and suction are the cause of the reversing currents I was able to verify by experiment. A plasmodium was placed under a microscope in such a position that the currents in the veins were easily observable, while the plasm mass controlling the flow was sufficiently distant, to the right of the objective, to allow a small and thin cover-glass to be lightly laid upon it, without obstructing the field of vision. Then, by bringing slight and momentary pressure to bear on the controlling centre by gently tapping the cover-glass with a needle, while watching the effects through the microscope, I was able to superimpose upon the normal currents additional movements exactly corresponding to the pressure applied, and the rebound therefrom. Each tap on the cover-glass caused the stream, according to the direction in which it was flowing, to shoot or jerk a short distance backwards and forwards, or forwards and backwards, before pursuing its normal course. That the artificial pressure merely accentuated the natural movements, without producing essentially unnatural results, was attested by the fact that the delicate network veins suffered no injury or alteration from the experiment.

The question next arising is, of course, as to the origin of the pressure and suction which cause the flowing movements. The

obvious inference is, that in an aggregated plasm-mass there is something in the nature of the plasm which causes it to alternately dilate and contract; and that owing to surfaces exposed to air being drier and therefore firmer than parts in contact with water, the force of the pulsations is expended on the streaming of the more fluid and extended portions of the plasmodium, as being the lines of least resistance. The time occupied by each alternate flow, viz. about a minute and a half, further suggests that the controlling pulsations of the plasm-masses may possibly be the result of a slow respiration; this being consistent with the interchange of gases between plasm and its environment, which is one feature of its constant chemical processes. That dilations and contractions do occur in plasmodia is also rendered likely by the fact that swarm-cells, by the fusion of which the plasmodia originate, contain vacuoles or vesicles which alternately enlarge and diminish, as if by reason of the gradual accumulation and discharge of certain contents. It may not be without significance that the contraction of these slowly pulsating vesicles in the swarm-cells occupies about a minute; because, allowing for altered conditions, this may be regarded as approximating to the minute and a half, or thereabouts, occupied by the alternate currents in plasmodia. Moreover, similar vacuoles are found in the granular plasm of plasmodia, and occasionally also in the hyaloplasm; and although some of these vacuoles are more stable, others slowly disappear and reappear, as in the swarm-cells. There must obviously be physical results of the distensions and easements of the plasm during these slow pulsations; and these are probably a partial explanation, at least, of the pressure and suction by which the streaming is produced. It is still more likely that the visible pulsations are but indications of a respiratory function inherent in the whole mass of the plasmodium; but which only finds full expression when circumstances favour the free circulation of the reversible currents under conditions already described.

When the temperature falls too low, or the air becomes too dry for these activities, the plasmodium, if not sufficiently mature to form sporangia, passes into a resting stage, and remains in a state of suspended animation, until warmer and damper times return. In this condition, the dry plasmodium, or sclerotium, as it is called, can be preserved for months, and then resuscitated by the application of water. Describing the reviving process,

Professor de Bary remarks that "if single cells of a sclerotium are watched, contractile vacuoles are seen to form in them, a few hours after they are moistened, and protrusion of motile branches and pseudopodia and the creeping forward movement, all begin as in plasmodia." In this passage he so closely associates the contractions of the vacuoles with the other visible activities of the plasmodium, that it is remarkable he nowhere suggests a relation of cause and effect; but he probably referred all these phenomena alike to the physiological constitution of the plasmodium, without stopping to consider them as possible links in a chain.

At this point, for the present, my inquiry ends, because the subject of this paper is restricted to the cause of the streaming movements; and therefore the ultimate physiological explanation is only implicated so far as it is necessary to support the physical explanation. But if it is a fact, as I believe, that pressure and suction, originating in rhythmic dilations and contractions of a slow respiration, are the main cause of the alternating currents, a plasmodium is an organism in which the biological processes are so abbreviated that in the most direct manner conceivable the functional energy by which it breathes is converted into the physical force by which it moves. In no simpler way can we imagine an organism living and moving, and maintaining its being.

THE GENUS HYDRACHNA.

By C. D. Soar, F.R.M.S.

(*Read March 20th*, 1908.)

Plate 21.

The name *Hydrachna* was first used by O. F. Müller in 1776, being applied to the whole family of water-mites known at that date. Later, in 1781, he figured and described forty-nine species, using *Hydrachna* as the generic name in each case. With the exception, however, of three mites (*Hydrachna cruenta*, *H. geographica*, and *H. impressa*), the original species have all been removed and placed in other genera. For example, the species which Müller named *Hydrachna crassipes* we now know as *Atax crassipes*, and so on, the various species being grouped in several genera according to the characteristics exhibited.

The whole of the water-mites, or rather, we should say, fresh-water mites—the marine forms being known as Halacaridae—are placed under the family name Hydrachnidae. The word *Hydrachna* is retained as a generic name only. Latreille, in 1796, was the first to use it in this restricted sense, regarding *H. cruenta*, Müll., as the type species of the genus.

No better arrangement could have been made than the adoption of the name *Hydrachna* for the genus with which it is now associated, one of the included species being the largest mite of the whole family, and one which was named by Müller in his work in 1776.

Müller's book on water-mites, published in 1781, was the first great work on this subject. Previous writers had mentioned them, and had figured some of the species, but it was reserved for Müller to write a work dealing exclusively with the Hydrachnidae; and although only three of his species have been retained in the

genus *Hydrachna*, others have been added to such an extent that the modern genus of this name includes more species than the total number of mites mentioned by Müller in 1781.

Hydrachna is perhaps not so interesting as some of the other genera because its species exhibit no great variety of colour, being nearly all more or less red, ranging from an orange-red to a blackish red, or black and red as in *Hydrachna geographica.* There is also no variety in the external structure, and no obvious sexual differences occur except in the genital area, whereas in some of the other genera we find a great deal of variation in external structure, the males and females often being very different in appearance.

The species of the genus we are now considering vary very much in size, *Hydrachna geographica*, the giant of the whole family, being as much as 8 mm. in length, whilst others measure as little as 1 mm. The swimming hairs on the legs vary slightly in number and in length. Some of the species of *Hydrachna* are fairly common, and where found are generally taken in great numbers. The Norfolk Broads district is the most prolific hunting-ground known to me as regards the number of species found. With the exception of *Hydrachna globosa* very little is known concerning the life-history of these creatures; and having dealt with this portion of the subject in a previous contribution I shall refrain from further reference to it in the present paper.

Generic Characters.

Body soft-skinned, usually papillated, with or without chitinous plates between or behind the eyes. Median eye always present. Rostrum projected forward nearly as far as palpus. Epimera forming four distinct groups. Swimming hairs present on legs. Claws on all feet. Genital area heart- or pear-shaped. No sexual distinction except in genital area.

With the exception of one species, *Hydrachna levigata*, Koen., all have a more or less papillated skin on the body part. These papillae assume various forms in different species. They may be

blunted or pointed, skittle or cone-shaped, thorny or staff-shaped. Piersig, in his key to this genus in *Das Tierreich*, very frequently employs this character of skin formation to distinguish one species from another; but although of great assistance in this respect it cannot always be relied on. There is great variation in this characteristic, some specimens exhibiting the papillose formation much more than others. It should be remembered, also, that the angle at which the skin is folded when examined under the microscope has much to do with the appearance of these papillae.

The most important character for the identification of species is the dorsal chitinous plate, or plates, between and behind the eyes, and upon this we may divide the genus into three groups. (*a*) Those having only one large plate (e.g. *Hydrachna scutata*, Pier.) which covers a considerable portion of the anterior dorsal surface, surrounding the median eye and running backwards some distance on the dorsal surface; (*b*) those having two distinct plates, one behind each eye as in *Hydrachna globosa*, de Geer., and (*c*) those with a thin chitinous ridge running back behind each eye, which ridge may be in one piece or split up into two or more pieces. Although these plates are mentioned as the most important character for the identification of species, it unfortunately happens that in some cases they are very difficult to see, the body skin and the plates and ridges being all of the same colour, and the extra thickness of the plates not always being enough to make them stand out in sufficient relief, so that the most careful lighting will not always enable us to distinguish the exact form which is so important for identification. But if the mites when caught are placed alive in the preservative solution suggested by Dr. Koenike,* the colour of the body skin will gradually fade away after death, and leave the chitinous plates and the other hard parts in their original colours. This allows the dorsal plates and other parts to be seen to the best advantage.

* Ten parts pure glycerine; ten parts distilled water; three parts citric acid.

Dr. Wolcott, the American writer on the Hydrachnidae, suggests that, as the genus is getting so numerous in species, it would be desirable to split it up into subgenera, using the papillae and eye-plates for that purpose. This is a good suggestion, and no doubt will be adopted when a monograph on the whole genus is produced ; but as we are here dealing with British species only, it will not be necessary to make the suggested subgenera now.

One of the most striking characteristics of this genus is the way in which the rostrum or capitulum is carried forward nearly level with the tips of the palpi. This appears, on examination, to be a sheath in which the mandibles are enclosed and hidden when not in use. The rostrum appears to be split on the upper edge, for after death it is often found that the mandibles have sprung out of the sheath and project forward along the dorsal portion of the rostrum. The mandibles are long and lancet-shaped, and are serrated on one edge. The stock of the mandibles extends some distance down into the body of the mite.

The epimeral plates are in four groups, the smallest in front and the largest behind. These plates vary in shape in different species, some being much rounded and others being very angular. Between the two posterior pairs of epimeral plates is placed the genital area. The shape of the genital plates is the only great difference in the external structure of the males and females. These plates also show different forms in different species, some having a deep bay in the anterior margin and others a slight indentation. The acetabula are also different, in some cases being all of one size, whilst in others two or more are much larger. In *Hydrachna dissimilis*, Halbert, the female has four larger acetabula in a row on the genital field.

We have, at present, twenty-one species of *Hydrachna* in Britain, fourteen of which have already been recorded, the remaining seven embracing three species new to the British fauna and four species new to science. Many probably remain to be discovered, as but few districts in the British Isles have been at all systematically worked.

Table for the Preliminary Identification of British Species of *Hydrachna*.

1. Body skin with papillae (2).
   Body skin smooth without papillae (1. *H. levigata*).

2. Body colouring symmetrically arranged in black and red (2. *H. geographica.*)
   With eye-plate in one piece (3).
   With two decided eye-plates (5).
   With only narrow chitinous ridges (8).
   With gland-plates well behind the eyes, and in some cases a small chitinous ridge or muscle attachment between the eyes and gland-plates (9).

3. Eye-plate much broader than long (4).
   Eye-plate wedge-shaped between the eyes, extending backwards into two horn-like projections, longer than broad (3. *H. paludosa*).

4. Plate oblong with rounded corners, both anterior and posterior line being curved inwards (4. *H. schneideri*).
   Plate of irregular shape. Posterior edge curved slightly outwards, anterior edge curved very much outwards between the eyes (5. *H. scutata*).
   Plate of irregular shape. Posterior edge curved inwards and anterior edge outwards (6. *H. cruenta*).

5. Papillae of skin rounded (6).
   Papillae of skin pointed or spine-shaped (7).

6. Eye-plates ribbon-shaped, widened on the anterior margin. Both ends rounded and slightly curved inwards (7. *H. conjecta*).
   Eye-plates angular in form, the apex pointing inwards at the posterior ends. Anterior portion rounded and projecting forward level with the eyes (8. *H. dissimilis*).
   Eye-plates broad, wedge-shaped at posterior ends, with a thick chitinous ridge on outer margin running to the posterior points (9. *H. globosa*).

7. Eye-plate short and broad and gently curved towards median line on the outside posterior margin of plate; ends of plate much rounded (10. *H. thoni*).
   Eye-plate short and broad, the outside line bowed inwards towards posterior margin (11. *H. biscutata*).
   Eye-plate long and narrow, the inside edge of each plate forming one curve towards median line (12. *H. georgei*).

8. Eye-plate with a square projection on outside edge of each plate; posterior ends of plates tongue-shaped (13. *H. distincta*).

9. Ridge short, commencing on inside margin of each eye, and extending only a short distance backwards (14). *H. leegei.*
   Ridge short, placed just behind each eye (15. *H. maculifera*).
   Ridge extending from between the eyes to about the same distance backwards as eyes are wide apart; ridge much bent (16. *H. comosa*).
   Ridge very long, anterior portion straight; posterior portion curved and extended outwards (17. *H. bivirgulata*).

10. Body colour light red (10).
    Body colour very dark (11).

11. Mite large, about 5 mm. long, with two small ridges just behind the eyes and two gland-plates farther back, the whole forming nearly a square (18. *H. halberti*).
    With gland-plates only, one behind each eye a little farther back than breadth of eyes (19. *H. williamsoni*).

12. Mite small, with two small chitinous ridges just behind the eyes, and two gland-plates well behind (20. *H. fuscata*).
    Mite large, similar to above, with the chitinous ridges or muscle attachments about half-way between the gland plates and the eyes (21. *H. incisa*).

1. **Hydrachna levigata**, Koen.

This mite was described by Dr. Koenike in the *Zoologischer Anzeiger*, in 1897. It is easily identified, being, as far as is at present known, the only species of *Hydrachna* with a smooth

skin. There are no papillae visible. The specimen described by Dr. Koenike was a male measuring about 3·5 mm. My own specimen was a female measuring about 5·0 mm., of a bright red colour with a pale patch on the dorsal surface. I had only one specimen, which was sent me from the Norfolk Broads by Mr. Browne. This is the first time this species is recorded as British. It is not necessary to give a figure, the smooth skin being quite sufficient for identification.

2. **Hydrachna geographica**, Müll.

There is no difficulty in recognising this mite. It is larger in the adult stage than any other species amongst the Hydrachnidae. The females in some cases measure as much as 8 mm. in length and the males 6 mm. In addition to this the colour is symmetrically arranged in masses of black and red. I have not seen an adult, but I once took in Epping Forest three nymphs from a small pond at Snaresbrook. These were of a very large size. I have visited the same pond many times since, but have failed to find any more specimens. I have found this species mentioned as very common round London, but up to the present I have failed to find it except where mentioned above. Recorded in *Science Gossip*.

3. **Hydrachna paludosa**, Thon.

The entire mite is of a red colour. Male about 2·6 mm. in length. It is a well-marked mite, the plate behind the eyes being deeply bayed in from the posterior margin (Plate 21, Fig. 6). It has been recorded by Mr. Halbert from Ireland and from the Norfolk Broads.

4. **Hydrachna schneideri**, Koen.

Female about 2·6 mm. in length with oblong dorsal plate much wider than long (Fig. 7). This species, which has not been previously recorded as British, has been found on the Norfolk Broads and in Epping Forest. The swimming hairs on the legs are rather longer than those usually found on species of *Hydrachna*.

5. **Hydrachna scutata**, Pier.

Female: length about 3·4 mm. Common in Britain. Mr. Halbert records it from Ireland. It can be identified by the form of its dorsal shield (Fig. 8). This plate is not always so well formed as in the particular specimen from which this figure was drawn, sometimes being very irregular in outline. The skin is covered with pointed papillae, and the chitinous skin of the dorsal plate is very finely granulated. The median eye is very plainly visible on the plate between the pair of eyes.

6. **Hydrachna cruenta**, Müll.

Male about 2 mm. This is the type species of the genus, but it is not at all a common species with us. I give a figure of the dorsal plate (Fig. 9). This specimen was taken in the Warren, Folkestone.

7. **Hydrachna conjecta**, Koen.

Male about 2·5 mm. in length, very light red in colour. Plate narrow and ribbon-like (Fig. 12). Already recorded from England and Ireland.

8. **Hydrachna dissimilis**, Halbert.

Male about 3 mm. This beautiful mite was found in Ireland and described by Mr. Halbert. It was taken in a brackish ditch on the coast of County Wexford. The skin is covered with rounded scale-like papillae. The genital plate of the female has four unusually large acetabula across it, that of the male having two, one on each outer edge.

9. **Hydrachna globosa**, de Geer.

Female about 3 mm. long. Male about 2·5 mm. This is rather a common mite in Britain, having been recorded from England, Scotland, and Ireland. The skin is covered with rounded papillae (Figs. 1 to 5, and 11).

10. **Hydrachna thoni,** Pier.

Colour, light red. The nymph only has been found. Length, 1·5 mm. Skin covered with sharp-pointed papillae (Fig. 14). Norfolk Broads.

11. **Hydrachna biscutata,** Sig. Thor.

Very similar to *H. thoni*. The papillae of the skin are also sharp-pointed, but much shorter (Fig. 15). The eye-plates are of a different shape from those of the preceding mite. Mr. Halbert suggests that as this nymph is nearly always found in company with *H. scutata*, Pier., it may turn out to be the nymph of that species; but I have certainly taken what I think to be the nymph of *H. scutata* with one plate only, not the plates as found in *H. biscutata*. The finding of an adult will settle this point. The nymph only has been found. Lincolnshire and Ireland.

12. **Hydrachna georgei,** n.s.

This species was taken in Osborne Dyke, Norfolk Broads, in 1905. It is a small mite, the female being about 2 mm. long. The skin is covered with very fine rounded papillae. The eye-plates are long and narrow (Fig. 16). The genital plate has a very deep narrow bay on the anterior margin. The acetabula are all about one size, none being strikingly larger than the others. The epimera of the fourth pair are much rounded on the posterior edges. I name this species in honour of Dr. George, who, I believe, was the first to write about the Hydrachnidae in England.

13. **Hydrachna distincta,** Koen.

Female about 2·3 mm. in length (Fig. 10). Found in Lincolnshire.

14. **Hydrachna leegei,** Koen.

Female about 2 mm. in length. Of a very bright red colour. Recorded from England and Ireland. This species may be

easily known by the two small elongate plates on the body skin near the inside edge of the eye-capsules (Fig. 11).

15. **Hydrachna maculifera**, Pier.

Mite red, with dark markings on dorsal surface. Female about 2·4 mm. in length. This mite has small plates just behind the eyes. Recorded from England and Ireland (Fig. 18).

16. **Hydrachna comosa**, Koen.

Female about 3 mm. long. Third and fourth pairs of epimera short and wide. The eye-plates in this species become long bent ridges of chitin (Fig. 19). Norfolk Broads. This is the first record of this species as British.

17. **Hydrachna bivirgulata**, Pier.

Female about 3·2 mm. This species is very rare, having only been taken at present from the Norfolk Broads area (Fig. 24).

18. **Hydrachna halberti**, n.s.

A large mite, deep red in colour; female 5·2 mm. long. Genital area with a deep inbaying. Skin covered with rounded papillae. On reference to Fig. 21, and comparing it with Fig. 22 (*H. incisa*, Halbert), it will be seen that the chitinous plates, or muscle attachments, behind the eyes are very much alike in both species, except that in *H. halberti* the plates are close behind the eyes, whereas in *H. incisa* they occupy a central position. This species was found in Osborne Dyke, Norfolk Broads, by Mr. Browne.

19. **Hydrachna williamsoni**, n.s.

Male about 3·9 mm., dark red, with darker markings on dorsal surface. There are no plates or muscle attachments between the eyes and hair glands such as will be seen on Figs. 21, 22, 23, but a clear space (Fig. 20). The genital plates have two acetabula, one on each side, much larger than the others.

Norfolk Broads. Named in honour of Mr. Williamson, of Edinburgh, well known as a writer on the North British Hydrachnidae.

20. Hydrachna fuscata, n.s.

Female 2·4 mm., male 2·1 mm. in length. A very dark-coloured mite, appearing, when examined in water, almost black. The legs are red, marked with yellow at the joints. The skin is covered with fine rounded papillae. The genital area of the female has a very deep inbaying from the anterior margin. The male genital area is only very slightly curved inwards. The small chitinous plates or muscle attachments are close behind the eyes, but are placed a little nearer the median line than in *H. incisa* or *H. halberti*. This mite has been found in Lincolnshire, Shropshire, and Hertfordshire (Fig. 23).

21. Hydrachna incisa, Halb.

A very dark-coloured mite first described in 1903 by Mr. Halbert, by whom it was found in a pond near Carrigaline, County Cork, Ireland, in 1900 (Fig. 22).

It was my intention in this paper to give a list of localities where these mites have been found, on a scheme suggested to me by Mr. Balfour Browne, in which the British Isles are divided into counties and vice-counties, the divisions being numbered for convenience of reference and for the economising of space. Unfortunately, however, many of the gentlemen who have so kindly sent me specimens for examination in the preparation of this paper have omitted to supply me with sufficient data for the purposes of such a list. I am, however, gradually acquiring the necessary information, and hope to publish later a full detailed list on the lines suggested above.

I wish to thank the following gentlemen for the loan of specimens and mounted slides for the preparation of this paper: Mr. Halbert, of Dublin; Mr. Williamson and Mr. Evans, of

Edinburgh; and Mr. Balfour Browne, Dr. George, and Mr. Taverner for specimens from several districts in England.

Explanation of Plate 21.

1. Dorsal surface of *Hydrachna globosa*, to show the general form of the species of this genus.
2. Epimera and genital area of *H. globosa*. ♂.
3. Palpus, showing also projection of capitulum, *H. globosa*.
4. Eye capsule of *H. globosa*.
5. Genital area of female *H. globosa*.
6. Eye-plate of *H. paludosa*.
7. ,, ,, ,, *H. schneideri*.
8. ,, ,, ,, *H. scutata*.
9. ,, ,, ,, *H. cruenta*.
10. Eye-plates of *H. distincta*.
11. ,, ,, ,, *H. globosa*.
12. ,, ,, ,, *H. conjecta*.
13. ,, ,, ,, *H. dissimilis*.
14. ,, ,, ,, *H. thoni*.
15. ,, ,, ,, *H. biscutata*.
16. ,, ,, ,, *H. georgei*.
17. ,, ,, ,, *H. leegei*.
18. ,, ,, ,, *H. maculifera*.
19. ,, ,, ,, *H. comosa*.
20. Portion of dorsal surface of *H. williamsoni*.
21. ,, ,, ,, ,, ,, *H. halberti*.
22. ,, ,, ,, ,, ,, *H. incisa*.
23. ,, ,, ,, ,, ,, *H. fuscata*.
24. ,, ,, ,, ,, ,, *H. bivirgulata*.

THE PROBOSCIS OF THE BLOW-FLY, *CALLIPHORA ERYTHROCEPHALA*, MG.—A STUDY IN EVOLUTION.

By W. Wesché, F.R.M.S.

(*Read June 19th*, 1908.)

Plates 22 and 23.

The proboscis of the Blow-fly is an object familiar to every microscopist, and I venture to suggest that it is not only a test for objectives, but also an equally critical test of powers of observation. I have met many persons who possessed preparations of this object, and were under the impression that they were familiar with its structure; but, as a matter of fact, they were unacquainted with many of its most interesting details, never gave a thought to the uses of the various parts, and, as to the question of evolution, or how such an organ came to be developed from portions of structure somewhat similar to those which we now find present in the cockroach, that was not even approached.

Ever since there have been microscopes and microscopic anatomists, the trophi of insects have been studied, and the fact that all are modifications of an ancestral form was realised by Savigny, one of the pioneers of his subject. It is quite consistent with this, that, although the mouth of the Blow-fly differs from the typical insect mouth in every detail, yet, with the exception of one pair of palpi, all the parts can be homologised with those of *Periplaneta*. The trophi in Diptera may be separated from every other insect mouth, by the curious tracheal and pseudo-tracheal structure. It is found developed

in those families which, judging from palaeontological evidence, are the oldest, and it is only when the mouth has been extremely modified for blood-sucking or raptorial purposes, that traces of it are completely lost, as in most Culicidae and Asilidae.

In the older forms the tracheae seem complete, forming perfect rings, and the tubes are much finer and smaller than in the Blow-fly. The lobes of the paraglossae (labella) are much more fleshy, and their under surfaces are usually more chitinised and more thickly haired. But the greatest differences are in the chitinous framework which supports the labium.

In the Blow-fly this consists of two plates, an upper or dorsal, and a lower or ventral; these extend from the base of the labrum and hypopharynx (the lancets) to the base of the labella. The upper plate consists of a thin middle plate on which the lancets rest, and two stout lateral rods which on dissection easily separate from the plate (Plate 22, Fig. 2), while the lower part or mentum is a stout homogenous plate of chitin, slightly bent upwards at the sides (Fig. 1).

In *Tipula oleracea*, L., most of the species of the same family, and also the Ptychopteridae, all of which might be called Crane-flies (the older families previously alluded to), there is no upper plate with lateral rods, but lying just under the upper surface, and in the median line, is a long flat rod with a bifurcation at its anterior extremity; to the ends of this bifurcation are attached the maxillary palpi. A microscopical examination of this rod shows that it is composed of two rods fused together, and it can be seen that the entire piece is produced by the fusion of the levers (the cardines and stipes) which work the maxillae, and are aborted in these insects (Fig. 4). They can be clearly recognised in the Blow-fly as two lateral rods in the posterior portion of the proboscis, which end at the base of the lancets (labrum), but are not attached to the palpi, which are labial (Fig. 3).

On the ventral side of the proboscis in the Crane-flies is a second rod, with a shorter bifurcation, which seems hinged on to several chitinous processes at the base of the labella. This part, like the parallel rod above, when examined with higher powers, is seen to consist of a fusion of two rods or plates, so that it cannot be a modification of the mentum, a homogeneous plate, which we have seen is situated in a similar position in the Blow-fly (Fig. 5). This ventral rod can also be found in species of *Bibio*, *Dilophus*, and *Psychodidae*, all belonging to the older group in the flies (Fig. 6). Two types of proboscis have been examined, one the Blow-fly with plates above and below, and levers at the posterior part, and the other the Crane-flies with rods above and below, and without the levers at the posterior end.

We now take a third type, which resembles the proboscis of the Blow-fly in the shape of the labium, and also has a number of tracheae permeating the structure of the labella. This is the proboscis of the Breeze-fly, *Tabanus bovinus*, L. If this be examined it will be found that both the upper and lower surfaces of the labium are without the plates and rods that are present in the corresponding parts in the Blow-fly or the Crane-flies. The reason is apparent when we find this insect furnished with broad-bladed mandibles and strong maxillae; to these maxillae are attached the palpi, and their bases are fused to rods, which represent the stipes and cardines, present in similar situations in the Blow-fly, but absent from the base of the labium in the Crane-flies owing to a migration to a more anterior position (Fig. 13).

We can now go a step further and examine the mouths of some insects related to the Crane-flies which have, like those insects, lost the armature that is present in *Tabanus*. *Chironomus dorsalis*, Mg., is without parallel rods in the median line, although the levers of the maxillae are there, but in the normal posterior position, separate and attached to the palpi,

while on the under side are lateral rods which reach from the base of the labium to the bases of the labella (Fig. 7). In *Leptis conspicua*, Mg., which possesses the blades of the maxillae, and has only lost the mandibles, two rods are present on the under side exactly as in *C. dorsalis* (Fig. 8). In a fly nearly related to *L. conspicua*, *Chrysopilus auratus*, F., the lower plate (mentum) is present, exactly as in the Blow-fly, but with this structural difference, that two rods have been incorporated into it, these being fused in the median line and sending out forked processes at the anterior end (Fig. 9).

In a number of families related to these older types, a similar structure of the mentum will be found. In the Stratiomyidae, Bombylidae, Empidae, Dolichopodidae, Phoridae, Lonchopteridae, and Platypezidae, practically all the species examined exhibit an arrangement of the parts similar to that which exists in Chrysopilus. All these families agree in this particular, and all differ from the Blow-fly.

We can now see that the differences in the proboscis in these two sections have been brought about by the incorporation of the mandibles into the structure of the labium; in the Blow-fly they appear to be embedded on the dorsal side of the labium, and are represented by the two stout lateral rods previously referred to. In the older families we find species which have the mandibles (1) fused together and situated in the median line on the ventral side of the labium, as in *Tipula* or *Bibio*, (2) present as lateral rods, as in *Leptis* or *Chironomus*, or (3) fused into the mentum, as *Chrysopilus* or *Dolichopus* and the majority of the Brachycera.

The larvae of the huge family of the Muscidae, to which the Blow-fly belongs, escape from the pupa-case through a circular opening, whilst all the others mentioned, with the possible exception of the Platypezidae, escape through a T-shaped opening. The character of the mentum follows the character of the pupa-case, which differentiates these flies as belonging to two great

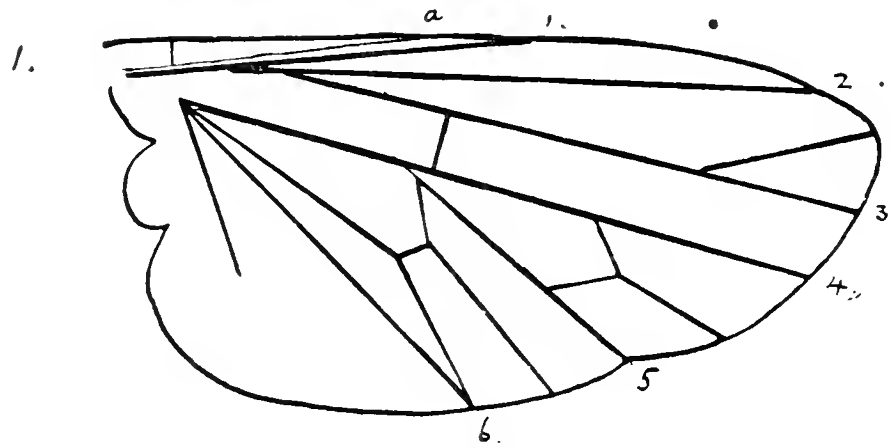
tribes, the Cyclorrapha and the Orthorrapha, descended from related ancestors.

We have now separated the group of families to which the Blow-fly belongs from a number of the other families by a character in the proboscis, and this is confirmed in a remarkable manner by the character of the pupa-case. It therefore seems highly probable that this character is a reliable one, and, as I shall show, enables me to trace the pedigree of the Blow-fly further back, to the point where it separates from the families known as the Brachycera. I have already shown that in the Leptidae two nearly related insects have two types of structure on the ventral side of the proboscis, one (*L. conspicua*) with lateral rods, and another (*Chrysopilus*) with a plate in which, judging from appearances, these rods are embedded. I can also show that in the nearly related Tabanidae many species are without the mentum, as in *T. bovinus*, but it will be found fully developed in *Haematopota pluvialis*, L., and without any sign of the thickening in the median line, owing to the insect possessing fully developed mandibles (Fig. 10); in fact, in a similar condition to that which is found in the Blow-fly.* This fly is a well-known British species, and is, I believe, popularly known in some districts as the "grey Clegg." I have little doubt but that in this genus is found a form approximating to the ancestral form of the Muscidae; but the "branching off" took place at a very remote period, before the Tabanidae lost the labial palpi.

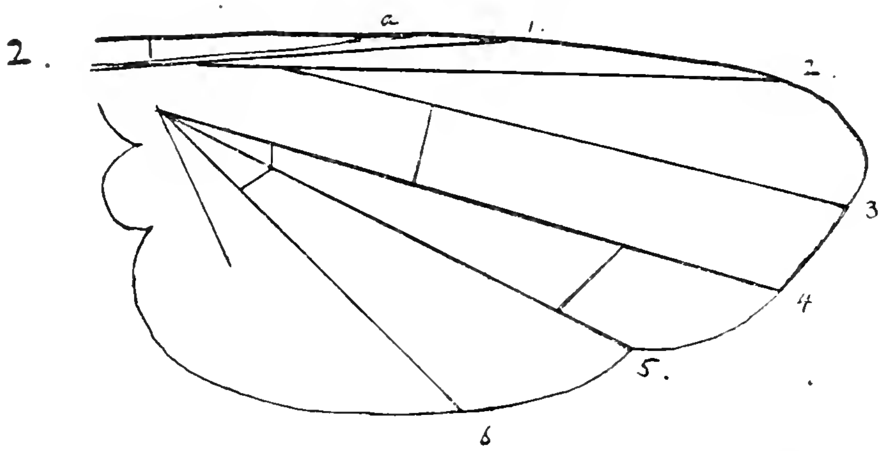
The venation of the wings has, like the mouth, undergone simplification, but confirms this hypothesis in a striking manner. It must, however, be understood that the Blow-fly is itself one of the later Muscids, for the older forms of venation are represented in the Anthomyidae (Fig. 2, p. 288).

* As a "control" observation an exotic *Haematopota* has been examined (*H. pertinens*, Austen, from British Central Africa), and the mentum is practically the same as that described above (Fig. 12).

Summary.—It has been shown that the two large sub-orders in Diptera, the Orthorrapha and the Cyclorrapha, are characterised, in addition to the method of escape from the pupa-case, by the manner in which the mandibles, when absent as separate



1. Type of the wing-venation in the Tabanidae The longitudinal veins are thus indicated throughout the figures: *a.* auxiliary; 1. first longitudinal vein, etc.



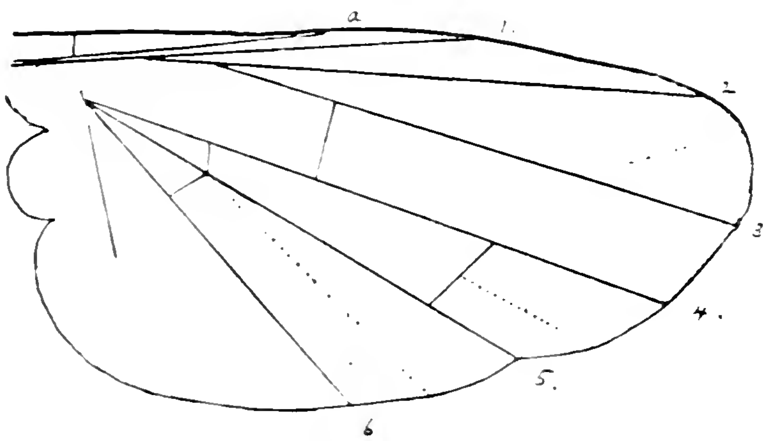
2. Type of the venation in the Anthomyidae (the earlier Muscidae). The homologies of the veins are indicated by the figures. This type shows the tendency in the later families for the venation to simplify and to leave the lower portion of the wing. It will be noticed that in the Tabanidae the wing is completely encircled by a vein (the costal), while in the Muscidae it is only present on the upper side and stops at the fourth longitudinal vein.

parts, have been incorporated into the structure of the proboscis. The presence of a similar mentum to that found in the Blow-fly (unique in the Brachycera, as far as my observations have gone) in *Haematopota*, shows that the Tabanidae must be very close to an ancestral form of the Muscidae.

Remarks on some Specialised Types of Proboscis in the Muscidae.

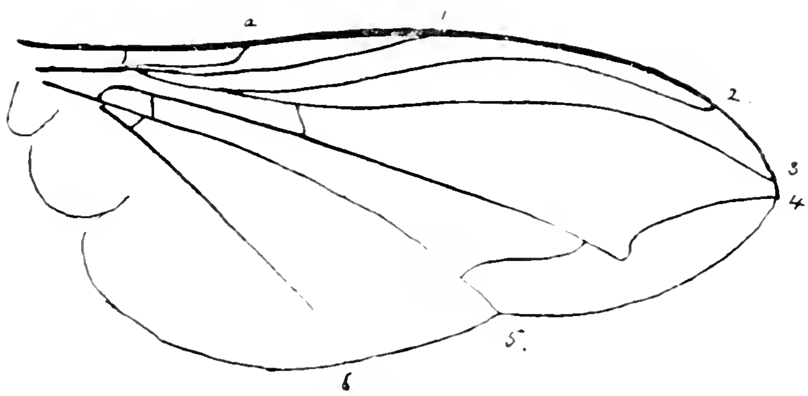
Considering the Muscidae alone, we find an enormous preponderance of a type similar to that of the Blow-fly, but with two other well-marked forms: (*a*) An elongation of the proboscis

3.



3. The same, but the intercalary veins present in the Tabanidae and lost in the process of simplification are indicated by dotted lines, showing the close approximation of the two types.

4.



4. Wing of the Blow-fly (*Calliphora erythrocephala*, Mg.), showing the actual venation. The bend of the fourth vein has been modified to afford increased stiffening to the distal portion of the wing, and consequently greater powers of flight.

accompanied by a geniculation of the labella, which bear well-developed though simplified tracheae, enabling the insect to penetrate the cavities of flowers and suck the juices (Plate 23, Fig. 1); and (*b*) a chitinising of the proboscis, owing to a greater development of the mentum, modifying the proboscis into a hard style, fitted for penetrating skin and sucking blood (Plate 23,

Fig. 2). We have several good examples in various degrees of development in our British fauna. Of the first, *Drymia hamata*, Fln., seems to be the most archaic form, as it has an older type of wing-venation than that which is found in the Blow-fly; apart from this, the proboscis is proportionately much less elongated than in the case of several species of *Siphona* and in *Prosena*, where it is nearly as long as the thorax and abdomen together; and in the blood-suckers, judging from the venation of the wings, we find a type which developed later than *Drymia* and earlier than *Siphonia* in *Stomoxys* and *Haematobia*, and in the exotic *Lyperosa*, whilst the African Tsetse flies (*Glossina*) show by the wing-structure and in many other points of anatomy that they are a later specialisation even than *Siphona*. Now the specialisations of the mouth follow these two types so closely that they might be thought to be reliable signs of affinity, although the venation of the wing would suggest that these specialisations took place at different periods of time; this is, however, not absolutely certain, as the venation may have changed with the specialisation, though, since I have shown that the two types of mouth have four, or, if we include *Madiza*, even five types of wing-venation, this seems highly improbable. I therefore think that these specialisations are on parallel lines of evolution and have gradually been adapted to meet the exigencies of each case. Additional probability is given to this suggestion by the fact that, in most large families, specialised types of mouth are found, which are a departure from the prevailing form; insects such as *Orthochile* in the Dolichopopidae, or *Rhingia* in the Syrphidae, are cases in point. Also in some of the Acalyptrate Muscidae, small species occasionally develop a long styliform proboscis, adapted for probing the finer tubes of flowers. In a family of which one species is probably familiar to most of us in the form of the cheese maggot (the larval form of *Piophila casei*, L.), an adaptation of this kind is found, namely in *Madiza glabra*, Fln.; but, as I have shown, this is no sign of relationship, but modification on

parallel lines leading to like results. One of our British blood-suckers, *Haematobia stimulans*, Mg., seems to have halted in a stage of development, as tracheae can be found (it is true, in a very degenerate state) at the end of the proboscis, which in all other respects is similar to that of *H. irritans*, L. All the flower-feeders show the taste-hair at the end of each trachea, exactly as it is found in the Blow-fly; and, as it is present in a similar situation on the labella in *Tipula* and *Ptychoptera*, it is obviously a very archaic organism.

There is yet another point which throws light on the evolution of the Blow-fly and these kindred specialisations, and that is the remnants of the maxillary palpi, those curious hairy processes which are attached to the stipites. They are very evident in a number of flies in the Anthomyia group of the Muscidae, where the fourth vein is straight, and are still obvious in genera of the Muscidae proper, where the vein begins to curve; but, as would be expected, they disappear directly the mouth is specialised, as in *Drymia* and *Stomoxys*, though *Drymia* has the straight and *Stomoxys* the curved vein. Where, however, the mouth is unspecialised as in the House-fly (*Musca domestica*), but the fourth vein is still more curved than in *Stomoxys*, the remnants are much less, but still persist, whilst in the Blow-fly they have disappeared altogether; so I am able to say with tolerable confidence that the mouth shows us that, although it is not one of the latest, it is one of the later types in the Muscidae.

Summary.—(1) That specialised types of the proboscis in the Muscidae do not show that the genera are more nearly related than is indicated by their inclusion in the family, but have arisen on lines of parallel development.

(2) That probably these genera branched off from the normal type in the following order, the oldest being placed first: *Drymia*, *Stomoxys*, *Haemotobia*, *Siphona*, *Prosena*, and *Glossina*.

(3) That the Blow-fly (*Calliphora*) is one of the later, though not specialised genera in the Muscidae.

Explanation of the Plates.

Plate 22.

Fig. 1. Mentum or ventral plate on the proboscis of the Blow-fly *Calliphora erythrocephala*, Mg., ♂ dissected out, flattened, and drawn to the same scale as the other parts of the trophi of the same insect. To show the absence of any median process and the characteristic chaetotaxy; the hairs and bristles on the mentum in the Brachycera (with the exception of Haematopota) being in my observation much fewer in number.

Fig. 2. Upper plate of the proboscis of *C. erythrocephala*, drawn from a preparation in balsam, the action of which has somewhat distorted the parts. To show the lateral rods.

Fig. 3. The labrum, hypopharynx, stipites and cardines of the maxillae, and submentum (fulcrum of Lowne) of *C. erythrocephala*, dissected out from the base of the labium and drawn laterally. To show the stipites and cardines in their normal position in the Muscidae; their usual function is lost, and they hinge on to the labrum. *lr.* labrum; *h.* hypopharynx; *s.* stipes; *c.* cardo; *sm.* submentum.

Fig. 4. The upper apodeme or lever, dissected out from the the labium of the Crane-fly, *Tipula oleracea*, L., and drawn to the same scale as the lower lever from the same insect. To show the median suture, indicating that it is a fusion of two rods, and the connection of the anterior processes with the maxillary palpi.

Fig. 5. Lower lever, dissected out from the labium of *T. oleracea*, showing some of the structure, indicating that this part is also a fusion of two rods.

Fig. 6. Lower lever, dissected out from the labium of *Bibio marci*, L. This occupies an identically similar position

with the lower lever of *T. oleracea* and is clearly homologous. To show the forked process at the posterior end, indicating that the part is a fusion of two rods.

Fig. 7. Ventral side of the labium of an undetermined *Chironomus*; the situation of the lateral rods is practically identical with that found in *C. dorsalis*, Mg. The surfaces only of the paraglossae (labella) are drawn, and consequently no tracheae are shown. To show the lateral rods on the ventral side of the base of the labium.

Fig. 8. Ventral side of the labium of *Leptis conspicua*, Mg.; the labella (paraglossae) have been flattened out, and the maxillae and maxillary palpi removed. The surface only is drawn, and consequently no tracheae are shown. To show the lateral rods, and for comparison with *Chironomus*.

Fig. 9. Mentum of *Chrysopilus aureus*, Mg., ♂ dissected out from the ventral side of the labrum. The part is nearly identical with that of *C. auratus*, F., but the latter is without the separation of the rods in the median line. Both these insects are nearly related to *L. conspicua*, and the wing-venation is similar. To show the presence of rods in the median line of the mentum, generally found on the trophi in the Brachycera.

N.B.—*C. aureus* is a small insect, and the part is shown at a much higher relative magnification.

Fig. 10. Mentum of *Haematopota pluvialis*, L. ♀ (grey Clegg), dissected out from the labium and flattened. To show the absence of any median structure, the chaetotaxy, and for comparison with *Calliphora*.

Fig. 11. Mandible of *Haematopota pertinens*, Austen, ♀. This Tabanid from British Central Africa is very closely related to our *H. pluvialis*, and has been examined as a control observation.

Fig. 12. Labium of *H. pertinens* ♀, lateral view; the hypopharynx, labrum, maxillae, maxillary palpi, and mandibles have been removed. To show the absence of any plate on the upper surface and of any median or lateral structure on the mentum. The situation and character of the tracheae have been indicated.

Fig. 13. Maxilla, maxillary palpus, stipes, and cardo of *H. pertinens* ♀. To show the connection of the palpus with the stipes and for comparison with Figs. 3 and 4. *l.* lacinia (maxilla); *mp.* max. palpus; *pf.* palpifer; *s.* stipes; *c.* cardo.

Plate 23.

Fig. 1. Proboscis of *Siphona geniculata*, Deg. The parts have been modified to enable the insect to probe the cavities of flowers; the smaller circle shows the paraglossae with the modified tracheae; the teeth, found on the corresponding part in the Blow-fly, have completely disappeared.

Fig. 2. Proboscis of *Stomoxys calcitrans*, L. The parts have been modified for blood-sucking. The smaller circle shows some of the teeth found on the paraglossae. The following letters are used on this plate: *lp.* labial palpus; *pg.* palpiger; *pr.* paraglossa; *mn.* mentum; *sm.* submentum; *lr.* labrum; *h.* hypopharynx; *s.* stipes of the maxilla; *c.* cardo of the maxilla.

HYMENOLEPIS FARCIMINALIS.

By T. B. Rosseter, F.R.M.S.

(*Read October 2nd*, 1908.)

Plate 24.

Taenia farciminosa, Goeze, 1782.
Taenia farciminalis, Batsch, 1786.
Hymenolepis (Taenia) farciminalis, Rosseter, 1908.

This tape-worm has had in its nomenclature a very chequered experience, having been respectively named *Taenia farciminalis*, *T. serpentulus*, *T. angulata*, and *T. undulata*. It has been found parasitic in the alimentary tract of the crow, starling, jay, and jackdaw.

Goeze (*Naturgeschichte*, 1782, p. 397, pl. 31B, figs. 19–21) was the first to find, describe, and delineate this tape-worm, and from the peculiar formation of the terminative or ripe segments of his specimen he named it *Taenia farciminosa*, or the sausage-shaped tape-worm—" Der Wurstgliedrichte Bandwurm." He took it from the intestine of the starling (*Sturnus vulgaris*), and his specimen was " Fünf Zoll," or 126–127 mm. in length. His drawings, executed by Graff von Borste, illustrate the scolex with the evaginated rostellum and suckers, the neck with commencing segmentation and sections of the middle and terminative segments of the strobila ; but nothing is figured, or mentioned in the text of the internal anatomy. The following is Goeze's description : " *Taenia farciminosa* : Articulis longiorobus farciminosis ; collo breviori simplici ; capite sub quadrangulari quadriosculato ; proboscide uncinulata." Unfortunately he does not substantiate the latter statement (uncinulata) by giving us a drawing of the hooks, or the number on the rostellum or proboscide.

Batsch (A. J. G. C.), *Naturgeschichte der Bandwurmgattung*, p. 198, figs. 132–133, Halle, 1786, restudied this worm and altered the name to *T. farciminalis*.

Rudolphi, in his *Entozoorum* and *Synopsis Entozoo.*, 262, p. 153, and *Synopsis*, p. 160 (1819), agrees with Batsch, but gives us no further particulars beyond dissenting from Frolich (J. A.), *Beschreibungen einiger neuen Eingeweidewürmer*, Halle, 1789 and 1802, in supposing that *T. farciminalis* and *T. infundibuliformis* were one and the same worm.

Dujardin's description of this tape-worm in *Hist. des Helminths Cestoides*, No. 90, p. 599 (1845), is very brief; evidently his acquaintance with it was a literal one, as he merely quotes Goeze and follows Batsch in his nomenclature.

Krabbe, *Bidrag til Kundskab*, No. 88, p. 321 (73), tab. 9, figs. 230–232 (1869), gathered together and unravelled the tangled threads of the various authors, other than those mentioned above, such as Creplin (Berlin, 1851); Kuchenmeister, *Ueber Cestoden*, Zittau, 1853; von Siebold, *Ueber die Band und Blasenwürmer*, Leipzig, 1854. He also stated that Friis, in October, 1867, took a specimen of the worm under consideration from the Jackdaw, and corroborated the fact that the specimens which the above writers had respectively found were undoubtedly the same as Goeze's *T. farciminalis*, although von Siebold thought his specimen was Schrank's *T. serpentulus*, which mistake Krabbe corrected. Krabbe gives us in his text, however, but little fresh description of the anatomy of this worm. He figures the hooks, and gives the number, from the rostellum of Creplin's, von Siebold's, and Kuchenmeister's specimens to illustrate the variability of their formation and contour of the roots. He also figures the egg with its two apparent envelopes and embryonic hooks, stating their length, from Kuchenmeister's mature specimen. Beyond this, however, he is silent. The following is his description: "Longit., 120 mm.; latit., 1 mm.; uncinulorum 10 corona simplex, quorum longit. 0·020–0·023 mm.; aperturae genitalium secundae; hamuli embryonalis, longit., 0·016–0·024 mm."

Blanchard (Dr. Raphael), *Hist. Zoo. et Méd. des Téniadés du genre Hymenolepis Weinland*, p. 69, 1891, in his description of the genus *Hymenolepis* (Weinland), refers to Weinland's suggestion not only to reunite in the genus *Hymenolepis*, "Les téniadés des mammifères mais encore un certain nombre de téniadés des

oiseaux," and after eliminating a great number of species in consequence, "qu'on ignorera la structure de leur appareil génital," he concludes: "En somme *Taenia serpentulus*, *T. angulata*, *T. nasuta*, et *T. farciminalis* sont les quatre seules espèces de téniadés des oiseaux que l'on pourrait avec quelque vraisemblance incorporer aux *Hymenolepis*."

Since Blanchard wrote the above, many species of avian tape-worms known then and since discovered have been transferred to the genus *Hymenolepis* by various helminthologists who have studied their anatomy, more especially by Dr. von Linstow.

Dr. von Linstow, *Archiv für Mik. Anat.*, Band 33, p. 452, Taf. 28, figs. 19–27 (1893), studied and wrote a memoir on *Taenia serpentulus*, Schrank (non Dujardin), but he did not at that time advocate its transference to the genus *Hymenolepis*, although he would in every respect have been justified had he done so, especially as his specimen had three testes. He justifies himself by saying that Weinland "wohl eine dreifache Eihülle gesehen habe," whereas in his specimen, "Die Eier haben eine doppelte hyaline Hülle." My reason for referring here to *T. serpentulus* is because the scolices of *T. farciminalis* and *T. angulata* agree with those of *T. serpentulus* in possessing the same number of hooks, viz. ten, and there is some superficial similarity between them; but a careful examination enables one to discriminate between them.

The bibliography of the strobila and the formation of the proglottides given by the various authors quoted above is very meagre and unsatisfactory, for beyond the statement of Goeze and the drawings he gives to substantiate his nomenclature we have in reality nothing to indicate the reasons for his name.

According to Krabbe it is very doubtful whether the specimen that Batsch had under consideration was *T. farciminalis*, or whether it was the same specimen as Dujardin describes in his *Hist. des Helminths*, No. 26, p. 569, as *T. undulata*. Krabbe gives us no dimensions of Batsch's worm.

Creplin, who took his specimen from the starling, at Greifswold, says that his specimen was 120 mm. long and 1 mm. broad. He describes the genitalia as being unilateral, and states that the

last segments contained embryonic eggs; but so far as Krabbe is concerned no mention is made as to the formation of these uterine segments.

Kuchenmeister also found it parasitic in the starling, and, like Friis, in the jackdaw; and von Siebold took it from the jay. According to Krabbe, the hooks on the rostellum in each case correspond with Creplin's specimen (Plate 24, Fig. 7). Kuchenmeister and von Siebold both saw the six-hooked brood. The latter states that his specimen was but 30 mm. long; but in neither instance are we enlightened as to the sausage formation of the terminative segments.

Krabbe, in his monograph, does not state that he had personally found this tape-worm, nor had had it submitted to him for examination. He evidently takes his basis of description from Creplin's specimen.

Thus I deduce from the above that none of the investigators since Goeze have possessed a worm of sufficient length for them to record, and thus corroborate Goeze in the "farcimen" formation of the terminative segments. Creplin's is the nearest approach to it in length, and I feel sure that had Creplin's specimen possessed the peculiar terminative segments indicative of Goeze's worm, Krabbe would have noted it in his *Bidrag*. Again, Krabbe thinks it possible that Batsch's specimen was the same as Dujardin's *T. undulata*. I have already shown in a previous paper on *Drepanidotaenia undulata* (see *Journal Quekett Micr. Club*, Ser. 2, Vol. ix., No. 58, p. 270, 1906) that Dujardin's *T. undulata* is in reality *T. angulata*. Thus if Dujardin's description of *T. undulata* (?) is, as Krabbe hints, quite in line with Batsch's *T. farciminalis*, it follows that the segments in either case must be, according to Dujardin, unlike those figured by Goeze for *T. farciminalis*, for Dujardin says of his *T. undulata*, that the terminative segments are swollen out "en forme de grain d'orge mondé deux fois aussi larges que longs" (*loc. cit.* No. 26, p. 569). Now although Dujardin's nomenclature of *T. undulata* and *T. angulata* is wrong, he knew, nevertheless, that his *T. undulata* (?) in no way corresponded with the description he gives of Goeze's *T. farciminalis*:

"Goeze compare ses derniers articles à des boudins ou saucissons (Farcimen)," *loc. cit.*, No. 90, p. 599.

The more one studies the Cestoidae, more especially those tapeworms which make birds, whether terrestrial or aquatic, their final hosts—which are the most numerous in species (Krabbe, in his day, enumerated nearly 200, and they have been added to considerably by recent discoveries—more especially by Dr. von Linstow of Göttingen)—the more one feels convinced of the futility of diagnosing a species, as the older helminthologists did, solely by the external appearances of the strobila or the formation of the individual proglottides, especially when it is known to be an armed species, and the hooks of the scolex are absent by caducity. I am not advocating a hard-and-fast rule, nor wishing to ignore external characteristics which a careful observer would note as a means of indicating to what species his worm belonged; but the strobila in the intestine is so liable to undergo such abnormal changes, more especially the terminative uterine portion of the strobila, as to make it difficult, without the cephalic hooks on the one hand and a knowledge of the internal anatomy on the other, to determine the species of the specimen in question. This is forcibly illustrated in Dr. von Linstow's diagrams of his new species (*Taenia hyperborea*) from *Canis lagopus*. I am led to the conclusion that it is the absence of any knowledge, either on the part of Krabbe or of the authors quoted by him, of this farciformation of the terminative segments of this worm that has been the cause of these writers specifically determining their specimens as Goeze's *Taenia farciminalis*; and although in some instances their specimens had uterine segments with the six-hooked brood, still, as I shall show farther on in describing and discussing the genitalia of this worm, there is a great difference in the form of the early uterine as compared with the older terminative segments.

I took my specimens from the jay (*Garrulus glandarius*) and the starling (*Sturnus vulgaris*). Of the former species one specimen in seven possessed them, and they were gregarious in the intestine. They varied in size, my longest specimen being 77—79 mm. long, and the mature or hermaphroditic segments

1—1·012 mm. broad. The scolex is subquadrangular (Pl. 24, Fig. 1), and possesses four somewhat bossed muscular suckers. The rostellum when dissected out is elliptical (Fig. 6), and bears a single row or crown of ten saddle-shaped hooks 0·020 mm. long (the *Dicranotaenia* form of Raillett). Fig. 7, *a*, *b*, *c*, shows the various forms of hooks given by Krabbe, and *d* is the hook from one of my specimens for comparison. The posterior root is short and curved in contradistinction to that of *T. serpentulus* (Fig. 8), which is long and slightly arched. It measures 0·006 mm. Another feature is that the anterior root is thick.

The length of the neck (Fig. 1) varies considerably, being in one of my specimens as long as 0·473 mm. According to Goeze it is 0·213 mm. in length, and segmentation commences at this distance from the scolex. In some instances, as exemplified by some of my specimens, there is an exception to this dictum of Goeze by segmentation commencing—as in the case of *T. serpentulus*—almost immediately from the base of the scolex. This I look upon as a variety caused possibly by cross-fertilisation. I say "possibly," but I might, perhaps, have used the word "positively," as I have taken different species of avian tape-worms from the intestine of the same bird in the act of cross-coition; but all my attempts to fix them for mounting under such circumstances have up to the present time failed. Goeze tells us that the neck is finely punctured, and that the middle segments—"Mittelglieder"—were studded with delicate cells. Seen with a $\frac{1}{16}$ in. oil immersion lens, these punctures or cells are resolved into minute pigment cells and calcareous corpuscles intermingled with the parenchymatous tissue. The pigment cells are not so numerous as the calcareous corpuscles, yet they are so thickly crowded together as to give a dark granular appearance to the neck and early segments (Fig. 10). The older segments are devoid of either pigment cells or calcareous corpuscles. The flat dull globes, as seen by Goeze in the middle segments, are very interesting morphologically. Considering that von Siebold's specimen was but 30 mm. long—this is but a quarter the length that Goeze gives for his worm—and that the terminative segments of von Siebold's worm possessed eggs with six-hooked

brood, I can but draw the conclusion that these "flache ovale Kugeln" seen and mentioned by him in the "Mittelglieder" of his worm were in reality the early-formed embryonic (six-hooked brood) eggs. I possess an old microscope by Cuff, which belonged to my great-uncle. It is complete with the series of six objectives and accessories. For comparison I have examined my specimens with these objectives. Goeze says his drawings were made from specimens examined with a "No. 3 objective," and assuming that Goeze in his day had nothing better to work with than No. 3 of my series of objectives belonging to Cuff's microscope, I can well understand his inability to satisfactorily discriminate the real form of these structures.

Fig. 1, *a—g*, shows the variability of the evolution of the proglottides in the strobila. Fertilisation takes place approximately 62 mm. from the scolex. Three mm. farther on they undergo a change owing to the gradual development of the uterus; but the segmentation of the ova—the "flache ovale Kugeln" of Goeze—at this stage is not far advanced. In the remaining 12 mm. the segments become gradually differentiated as uterine proglottides containing the perfected embryonic six-hooked brood, and, as will be seen on reference to Fig. 1, *f*, the whole character of the individual proglottis is changed. Seeing, now, that Goeze's specimen was 126 mm. long, or 47 mm. longer than my longest specimen, and taking into consideration the radical change that has taken place in the uterine segments of the terminative 12 mm. of the strobila of my specimens (the worm having previously cast off segregated uterine segments, as is indicated by the transverse posterior border of the succeeding segment, a change which renders them very conspicuous), one is left with a wide margin in the field of imagination as to the possibility of these remaining uterine proglottides—47 mm., 13 mm. longer than von Siebold's whole worm—transforming themselves into the "Farcimeniform" formation, as shown by Goeze in his *Naturgeschichte*, Tab. 31B, fig. 21, and which up to the present time, although Creplin's specimen was 120 mm. in length, no later investigator has corroborated.

From the time that the genitalia are formed, up to the develop-

ment of the early uterine segments, each individual proglottis is easily detached, transversely, from the strobila, and can be tilted and stood on its anterior transverse border like a long galley resting on its keel; and with careful manipulation a series of proglottides can thus be arranged on a slip of glass and mounted in glycerine, using Bell's cement and several final coatings of gold-size. A slight pressure of the cover-glass flattens out the segments, and the anatomical structure can thus be studied. It is better, in the first instance, to fix and stain the whole worm before disassociating the segments. Fig. 1, *d*, is not a microtome section, but a segment so flattened out under a cover-glass. In the later uterine segments this is an impossibility, owing to the elongation of the lateral borders.

So much has been written by various helminthologists on the nature of the cuticle and the structure of the proglottides of Cestoidae that I think this is not the place to discuss them in detail. It will suffice to say respecting *T. farciminalis* that the longitudinal muscles are enclosed apparently in a structureless membrane in fascicles or bundles. There are approximately thirty large and eighty-eight small fascicles running dorsally and ventrally through each segment. Of the former each fascicle consists of from ten to twelve muscle bands with a total diameter of 0·057 mm. In the latter the fascicle has a diameter of 0·027, and contains but four muscle bands. The smaller fascicles are posterior to the latter (Figs. 1 *d* and 9). Of the transverse muscles other than the fibrous net-work there is a series of muscles which require more than a passing notice. In the strobila, as the genital organs are developed, there is evolved a series of eight to ten transverse muscles grouped in the extreme anterior portion of the segment, and running both ventrally and dorsally from each lateral border. In these early hermaphroditic segments is also developed in connection with these muscles on either lateral border a scutiform cartilaginous body, to which the muscles are firmly attached (Figs. 11 and 12). Its anterior portion deflects obtusely for a short distance along the anterior transverse border. The attachment is formed by the terminative end of each muscle spreading itself

out into minute fibres or radicles in the form of a fan (Fig. 12), at this point having a breadth of 0·009 mm.; normally the muscles have a diameter of 0·003 mm. This scutiform body is more fully developed on the distal than on the proximal or pore border. The peculiarity in connection with this series of muscles and their connective body is that as the uterus develops they gradually deteriorate until they break away from their attachment, hang in threads, and finally disappear; and the only indication of their previous existence is a series of minute serrated nodules on each lateral border. On the detachment of the muscles the scutiform body springs away clear of the segment, and protrudes as a bent rod. It gradually wastes by absorption, and previous to the segregation of the ripe segment it has quite disappeared. An ordinary observer might be led to suppose that it was an accessory functional organ. These muscles are sub-cuticular, as they overlay dorsally and ventrally the large and small longitudinal muscles. Their appearance previous to and disappearance after impregnation indicate physiologically that they are temporary in their character, and merely strengthen the segment during coition, fecundation, and transition by gastrulation of the embryo to the alternative hexacanth stage.

The nerve in the segment is 0·304 mm. from each lateral border, and has a diameter of 0·027 mm.

There are four longitudinal vascular canals, two proximal and two distal; they make a junction with the transverse canals, which like the longitudinal are ventral and dorsal in the segment.

The genital aperture is situated on the anterior dextral lateral border. In its normal condition it is crateriform, its edges being concavely depressed. As the genitalia are perfected it swells up in the form of a boss, and is in reality the male genital pore (Fig. 11). This protuberance previous to coition is elevated 0·067 mm., and consists of longitudinal and circular muscular fibres. Its base is enlarged to 0·09 mm., and it is 0·067 mm. in diameter. After coition, when the receptaculum-seminis is filled with sperm, this protuberance becomes depressed within the cavity, and the lateral border resumes its normal

condition; the crateriform aperture still exists, and is not obliterated in the uterine segments.

The male organs are dorsal and the female ventral in the segment.

There are three testes, one proximal and two distal (Fig. 2, *t*, *t*, *t*). These are all semi-oval, almost pyriform. The proximal has a diameter at its basal or widest portion of 0·102 mm., whilst the distal testes are a trifle larger, being 0·106 mm. in diameter. One is slightly anterior to the other. The efferent duct (Fig. 2, *d. e.*) of the extreme distal testis makes a junction with the duct of the other, whilst the efferent duct of the proximal runs distally, curves slightly, makes a junction with and pours its semen into the vas-deferens. The vas-deferens (Fig. 2, *v.d.*) swells at intervals into small vesicles (Fig. 2, *vsc.*); these collapse, and cause the onward progress of the sperm into the vesicula seminalis (Fig. 2, *v.s.*). This is a long attenuated sac with a filiform sinuous ductus efferentia which a little farther on swells out into an "expulsion-blase" lying within an ampulla-formed cavity, a continuation of the genital aperture (Figs. 2 and 17). The distal portion of the "blase" is a large swollen sac which is invariably filled with spermatozoa; then follows a slight constriction, then another bulb (the middle vesicle), again a constriction, and then another swelling, which is seen to be the cirrus-pouch containing the cirrus with its sheath. The middle portion is studded anteriorly with small glandular bodies which I take to be prostate glands. They are unequal in size, the largest having a diameter of 0·025 mm. The "expulsion-blase" is composed of longitudinal and circular muscular fibres, whilst retractor muscles radiate from it to the walls of the ampulla-sac (Fig. 11. *amp.*).

The cirrus (Fig. 2, *c.*) is a comparatively short, smooth, hollow rod 0·068 mm. in length, with a diameter of 0·007 mm. Diameter of sheath 0·02 mm., length of pouch 0·18 mm., diameter of pouch 0·031 mm. The cirrus is never, judging from my specimens, extruded to any great length, and the sheath is extruded with it previous to copulation. In fact, I have formed the opinion that in coition the sheath performs the function of a sucker to the vulva.

The female genital pore is situated posterior to the male in the same sinus (Fig. 11, *v.*).

The vagina is ampulla-shaped with a smooth interior. The vulva is composed of circular muscular bands radiating from the proximal endoderm of the vagina, their apical ends forming the vaginal pore. The pore has a diameter of 0·009 mm. In mature segments and previous to coition this—like the male pore—is elevated 0·014 mm. in the form of a truncated cone which at the time of coition enters the orifice of the pouch. For this reason I look upon the pouch as an exhaust cup for fixation during copulation, because when the receptaculum seminis is filled with sperm the vulvular muscles are relaxed, the pouch and cirrus are released, and, in some instances of which I have specimens in my preparations, the excess of spermatic fluid is seen issuing from the cirrus. The relaxation of the radial muscles causes the vulva to resume its normal position in the sinus.

The vaginal canal (Fig. 3, *v.c.*) at the base of the vagina is a sinuous filiform duct. In its further course it slightly distends, again becomes filiform, and terminates in the receptaculum seminis (Fig. 3, *r.s.*). The receptaculum is a long attenuated sac; its diameter at its most distended part, when it is filled to repletion with spermatozoa, is but 0·078 mm. It is homologous with the vesicula seminalis. This analogy is the more striking as the two organs lie side by side in the same plane in the segment. The efferent duct or fertilising canal is short, the ovarian ducts forming a junction on either side in close proximity to the pore of the ductus efferentia.

The ovaries (Fig. 3, *ov.*) are racemose. Each raceme is filled with ova, and throws off a duct into the main or ovarian duct (Fig. 3). Their separation into proximal and distal ovaries is only made perceptible by the junction of their ducts with the fertilising duct.

The yelk-gland (Fig. 3, *y.g.*) is situated in the median line of the ovaries. It is somewhat reniform, 0·084 mm. long and 0·051 mm. in diameter.

The shell-gland (Fig. 3, *s.g.*) is pyriform, and lies proximal of,

and in close proximity to, the yelk-gland. Its stalk or duct is very pronounced, as it arches upwards over the yelk-gland and forms a junction with the yelk-duct, into which it pours its secretion. The whole of these ducts are so intermingled as to make them very difficult to trace, except by staining and careful manipulation.

The uterus in its early inception is dendritic (Fig. 1, *d.*). It lies in the median transverse plane of the segment proximal and distal, and dorsal to the ovaries. As the racemes of the ovaries empty their contents they are absorbed and the uterus takes their place in the proglottis. One would imagine that the involutions of the dendritic papillae on each side of the canal would develop into a pouch or sac, instead of which the developing of the ova into the six-hooked brood causes the involutions to swell up on a level with the papillae, and thus the whole forms a common uterine sac, characteristic of the genus *Hymenolepis* (Weinland) (Fig. 1, *e.*). The uterus is confined to 0·7 mm. from each lateral border.* The uterine eggs (Fig. 4) or six-hooked brood are sub-spherical, approaching an oval. Their polar axis or length varies from 0·05 to 0·076 mm., and their equatorial diameter is approximately 0·063 mm. They possess three envelopes. The space between the outer and middle envelope is 0·014 mm., and between the second and third 0·007 mm.; whilst the embryo is 0·034 mm. long and 0·27 mm. in diameter. These figures of size and space must not be taken as fixed quantities, but rather approximately, as they vary very much in different examples. The embryonic hooks are 0·013—0·015 mm. in length. The outer envelope is smooth and diaphanous, and the intervening space between it and the second envelope is filled with a glairy matrix. The middle envelope is somewhat pellucid and wrinkled, the wrinkling being caused by the cellular vitelline detritus, which fills up the narrow space between it and the third envelope. The third or embryonic envelope is ovular and diaphanous. It is conical at each pole. There is apparently no capsule, but by the aid of a $\frac{1}{16}$-inch oil immersion objective each

* There is sometimes an exception to this, the uterus extending itself in the form of a pouch at the distal anterior lateral border of the segment.

cone is seen to be bi-papillated. Whether, however, there is an orifice or channel leading into the embryonic space through the indentation of the poles, I am unable to say. The perfect embryo or six-hooked brood is plano-convex. It gastrulates at its planular or ventral end, the embryonic hooks lying equidistant in the gastrula cavity. In the early uterine stage, and also after the development of the six-hooked brood, the third envelope is scarcely perceptible—in fact, very difficult to discriminate; but in those segments, as in Fig. 1, *f*, which are ripe for segregation the embryo lies free in the cavity (Fig. 4, *e*), its homogenity—due to the using up of the nutritive cells—causing it to occupy a smaller space in the capsule. In these segments a remarkable number of ovarian or unfertilised eggs are mingled in the uterus with the hexacanth or six-hooked brood.

In conclusion, the following question may be asked: "What character can we draw from structural details which may be used as a criterion by future investigators in determining this species of tape-worm as Goeze's *T. farciminalis* in specimens lacking the scolex, hooks, and sausage-formed proglottides?"

It would be waste of time and space, and, in fact, misleading, to discuss the proposition on the basis of external structures alone, and therefore we must seek some other salient point of the internal anatomy which will enable us to determine a portion of the strobila, or even a single segment, generically and specifically.

(1) *Generically.*—The sexual pores are marginal, secundae, or unilateral, situated on the left of each succeeding segment. That of the male is dorsal, whilst the ventral is occupied by the female genital apparatus. There are three testes, one proximal and two distal, in the segment. The segments, being thus constituted, would fall within the genus *Hymenolepis*, Weinland.

(2) *Specifically.*—There are some minor peculiarities and points in connection with the genitalia which might be enumerated to assist the investigator in the diagnosis of this worm; but there is one portion of the female genitalia which, I think, should set at rest any doubt in determining specifically any detached or isolated proglottides as being a portion of the strobila of *H. farciminalis*, viz. the receptaculum seminis.

We will assume that the investigator is acquainted with *Hymenolepis serpentulus* from the fact of his having found this avian tape-worm and studied its anatomy; or, if not, that he is at least acquainted with Von Linstow's work on *Taenia serpentulus*. I have selected *H. serpentulus* because both generically and specifically there is an affinity, in some points morphologically, between this species and *H. farciminalis*. But if we select the receptaculum seminis as a point for comparison, we shall at once be convinced that in the segments before us we have not *H. serpentulus*. The receptaculum of *H. serpentulus* is a large, irregular, pear-shaped sac. Its anterior portion measures 0·37 mm. and its posterior 0·18 mm. in diameter, and, to quote Von Linstow, "*sie ist das grösste Organ in der Proglottide.*" Compare this with the description given above of the same organ in the segments under consideration, and it is sufficient to convince us that our specimen is not *H. serpentulus*.

Again, the question may be asked: "Is it necessary to base our conclusions on structural internal characters for the determination of a genus and species of the Cestoidae?"

It certainly is so, in the absence of the hooks of the rostellum, either by caducity, or, as so often occurs, by the scolex being left in the mucous membrane of the intestine; or, again, from the species being inerme, as in the case of *Taenia* (*Hymenolepis*) *megaloon*, Von Linstow (St. Petersburg, 1901).

For more than a century and a quarter this tape-worm has been known to helminthologists as Goeze's (Batsch's) *Taenia farciminalis*. Railliet, following Blanchard, and, like Weinland, recognising the fact that something more distinctive was required in diagnosing the various species embodied collectively in the genus *Taenia*, formulated the genera *Dicranotaenia*, *Drepanidotaenia*, and *Bothriotaenia*. From the formation of the hooks on the rostellum, *farciminalis* falls, as *serpentulus* would, into the first of Railliet's genera; and we should classify it as a *Dicranotaenia*, and turn to Krabbe's *Bidrag* for figures of the hooks to determine our species. But this classification of Railliet's only partially meets the case, as if the hooks are absent we require some other character in order to recognise the genus to which our species belongs.

The study of the genitalia of *H. farciminalis* has led me to the conclusion that it can no longer be retained in the heteromorphic genus *Taenia*; and as it possesses essentially the qualifications formulated by R. Blanchard in 1891 in defining the genus *Hymenolepis*, Weinland, even as regards the ovum possessing three envelopes, therefore, although it has retained the generic name of *Taenia* for the past one hundred and twenty-five years, I have decided to remove it from that genus to the genus *Hymenolepis*, Weinland.

Finally, I might point out a conclusive specific characteristic other than the "farcimen" form of the segments. The receptaculum seminis of avian tape-worms is, as a rule, variable in form and size. It may be pyriform, orbicular, or oval. Let us again take *Hymenolepis serpentulus*, one of the *Dicranotaenia*, for comparison. Contrast the gigantic *samen-blase* of *H. serpentulus* and its aborted vaginal canal with the elongated, filiform, medio-constricted *samen blase* of *H. farciminalis*, and its long, slender vaginal canal, and it will readily be conceded that these characters form convincing proof of the distinctness of the two species.

Explanation of Plate 24.

Fig. 1. Portions of strobila: *a*, scolex, neck, and early segmentation, × 35; *b*, succeeding segments with commencing formation of genitalia, × 18; *c*, mature hermaphroditic segments, × 18; *d*, an inverted segment, as described in text; *d.u.*, dendritic uterus; *l.m.a.*, long muscles anterior; *l.m.p.*, long muscle posterior, × 18; *e*, uterine segments; *u.*, uterus, × 18; *f*, terminal segments with six-hooked brood, S.B., showing the transition of the segments to Goeze's sausage or pudding formation, × 18. Fig. 1, *ga*, segment showing further evolution of proglottides, × 9 (from another specimen). Fig. 1, *gb*, proglottis, × 9, from isolated segments taken from intestine of jay, whose only internal parasites were *H. farciminalis*. They contained empty six-hooked brood cases; by this I assume they were the final stage of the proglottis in the strobila. Fig. 1,

gc, proglottides of *T. farciminosa*, from Goeze's *Naturgeschichte*, tab. 31B, fig. 21.

Fig. 2. Male genital tract; *t.*, testes; *v.d.*, vas-deferens; *vsc.*, vesicles of same; *v.s.*, vesicula seminalis; *d.e.*, ductus efferentia of same; *e.b.*, expulsion bladder; *c.p.* cirrus pouch; *c.*, cirrus, × 75.

,, 3. Female genital tract; *v.*, vagina; *v.c.*, vaginal canal; *r.s.*, receptaculum seminis; *ov.*, ovaries with their raceme ducts; *ov.d.*, ovarian duct; *s.g.*, shell-gland; *y.g.*, yelk-gland; *u.c.*, early uterine canal, × 75.

,, 4. Ovum or six-hooked brood from Fig. 1, *f*, with three envelopes and embryo, × 350.

,, 5. Embryonic hook, × 1,400.

,, 6. Invaginated rostellum, × 350.

,, 7. Various hooks from scolex of *H. farciminalis*; *a*, Creplin's; *b*, Von Siebold's; *c*, Kuchenmeister's specimens, after Krabbe, × 920; *d*, from Rosseter's specimen, × 700.

,, 8. Hook from scolex of *H. serpentulus*, Schrank, for contrast, after Krabbe, × 920.

,, 9. Fascicule of *a*, anterior; *b*, posterior long muscles, × 155.

,, 10. *p*, pigmentary; *c.c.*, calcareous corpuscles from neck of tape-worm (diagrammatic), as seen with $\frac{1}{16}$-inch objective.

,, 11. Successive stages in the development of the scutiform cartilaginous body. No. 1 distal, No. 2 proximal lateral borders of segment during development of genital organs and previous to copulation, × 175. No. 3 distal, No. 4 proximal lateral borders of hermaphroditic segments during and after copulation; No. 4 shows the position of genital pore and sinus, also organs of copulation, at this stage. Lettering as Figs. 2 and 3; *g.p.*, genital pore; *amp.*, ampulla, × 175. No. 5 distal, No. 6 proximal lateral border of uterine segment, × 90. In these segments the scutellum is undergoing absorption, and has sprung away owing to relaxation of muscles from the lateral border.

,, 12. Scutellum with transverse muscles attached, × 350. The connective fibrous radicles are as seen with a $\frac{1}{16}$-inch objective, and consequently diagrammatic.

SOME BRITISH SPIDERS TAKEN IN 1908.

By Frank P. Smith.

(*Read November 6th*, 1908.)

Plate 25.

Although the past year, judging from the experience of co-workers, seems to have been a fairly productive one as far as arachnids are concerned, lack of time has prevented my devoting more than a few days to really systematic field-work. Several friends, however, have kindly submitted collections for identification, among which were included some species well worthy of record.

There seems, unfortunately, to be no material augmentation in the numbers of the very small band of workers who are seriously studying the spiders, and whilst this condition of things continues it is not possible to undertake extensive distributional work of any value. The most that one can attempt in this direction is the gradual accumulation of isolated records and the occasional publication of such as may be of possible interest to other workers. A distributional list for the British Isles, founded upon the records at present available, would convey the impression that all the spider-population of the kingdom had drifted into about a dozen counties. Again, many local lists are very misleading, inasmuch as they are fairly complete in some families but strikingly weak in others. To an inexperienced person this would suggest some interesting local condition which had modified the spider-fauna by favouring the development of certain groups at the expense of the remainder. The expert, however, by glancing down such a list, can usually find a much simpler explanation in the fact that the collector, not being a trained arachnologist, has simply devoted his attention to one or two methods of collecting—generally "beating" or "sweeping." The wiles of spiders are so refined, and their habitats so diversified,

that a great deal of ingenuity and an abundant experience are both very necessary as qualifications for successful collecting. The expert, also, can generally form some opinion as to what species he is likely to meet with in any particular district and season, and can modify his methods accordingly. As an instance of this, I was recently initiating a friend into the subtleties of spider-collecting, and during the course of an autumn ramble we found a brickfield plentifully littered with fragments of broken tiles. These I began to turn over, and obtained quite a number of *Erigone* and allied spiders; my friend imitated me, but invariably turned up a blank. Careful observation revealed the reason, and I pointed out that he turned the tiles too suddenly, with the result that the little spiders became alarmed, fell into the grass, and were thus lost. The next spring we were on St. Leonard's beach turning pieces of rock, under which *Gnaphosae* lurked in considerable numbers. Again I was successful, and again my friend had no luck. He somewhat indignantly reminded me of my remarks of the previous autumn, when I attributed his present want of success to the fact that he did not turn his pieces of rock quickly enough; but I was easily able to justify my statements by a few experiments. The rocks under which the *Gnaphosae* were concealed lay upon a pebbly beach, the spiders being enclosed in silken sacs attached both to the rocks and the pebbles. As soon as the rock was lifted the silk was torn, and the spider at once attempted to disappear amongst the pebbles. The only method, therefore, of making a successful capture was to turn the rock as suddenly as possible and seize the spider before it could escape.

The difficulty of obtaining comprehensive literature dealing with the British spiders is so frequently put forward as a serious obstacle to the study of this order that a word or two concerning this matter may not be out of place. It is an undoubted fact that a monograph of the British spiders would be of enormous value to the few workers interested in the Araneidea. But the cost of such a work would be very great, as the figures of the specific characters of each sex, apart from any other illustrations, would number about one thousand; and the demand would be so limited that considerable financial loss would, I think, be inevitable. Again, the nomenclature of the group is, at present, in a rather unstable condition, and it might, therefore, be

advisable to postpone the publication of anything in the nature of a "standard work" until the various modern writers are a little more in agreement in this matter. The minor literature of the British spiders is by no means extensive nor difficult to obtain, and a fairly recent list of species by the Rev. O. Pickard-Cambridge (1900) can be obtained for use as a working basis. In a group like the present, however, where identification is often a matter of considerable difficulty, no amount of literature will be of so much assistance to the beginner as a little personal help from an experienced worker; and in a field where monetary gain is out of the question and popular encouragement at a minimum, the tyro may depend on finding genuinely enthusiastic naturalists who will be ever willing to help him through his early difficulties.

I will take this opportunity of thanking those gentlemen who have kindly communicated specimens, especially Mr. E. Hayward and his son, Mr. A. E. A. Hayward, of Southampton, Mr. George P. Deeley, of Brierley Hill, Staffs., and Mr. W. Pinkerton, of Watford.

Family ATYPIDAE.

Atypus affinis (Eichw.), 1830.

1830. *Atypus affinis*, Eichw., *Zool. Spec.*
1861. ,, *sulzeri*, Bl., *Spid. G. B. I.*
1879. ,, *piceus*, Camb., *Spid. Dorset.*

Localities for this interesting tunnel-spider, popularly but erroneously known as the "trap-door spider," continue to be discovered in various parts of the South of England. Probably it is not nearly so uncommon as the difficulty of detecting it has led it to be generally supposed. On one side of a road running through the Bexhill High Woods large numbers of the tubes of this spider were noticed. One, on being dug out, was found to be considerably more than a foot in length. This is considerably above the average, being probably due to the nature of the soil, which in this locality contains a very large proportion of sand and is exceedingly friable. This species also occurs on the Addington Hills, near Croydon, chiefly by the side of a somewhat steep path leading down from the base of the broad steps near the refreshment rooms on the southern extremity of the hills. It should be remembered that it is practically useless to search

any slope other than one with a south or south-west aspect, and also that the tubes, when occurring in the heath country, are usually concealed under large overhanging tufts of heather.

Family DICTYNIDAE.

Ciniflo fenestralis (Stroem), 1768.

1768. *Aranea fenestralis*, Stroem, *Det. Trondh. Selsk. Skrift.*
1778. ,, *atrox*, De Geer, *Mém.*
1861. *Ciniflo* ,, Bl., *Spid. G. B. I.*
1881. *Amaurobius fenestralis*, Camb., *Spid. Dorset.*
1900. ,, ,, ,, *List Brit. Irish Spid.*

This species, although not by any means rare, is often confounded, especially in the female sex, with the very common *C. similis*, Bl. The form of the epigynae, as illustrated on Plate 25, Figs. 1 and 2, will at once decide the species. *C. fenestralis* occurs pretty frequently in the London area under loose bark. *C. similis* is more or less a house-spider, frequenting holes in walls and crannies between boards in out-buildings.

Protadia subniger (Camb.), 1861.

1861. *Drassus subniger*, Camb., *Ann. Mag. N. H.*
1861. *Lethia stigmatisata*, Menge, *Preuss. Spin.*
1879. ,, *mengii*, Camb., *Spid. Dorset.*
1879. ,, *puta*, ,, ,, ,,
1881. ,, *subniger*, ,, ,, ,,
1889. ,, *albispiraculis*, Camb., *Proc. Dors. F. Club.*

During May several specimens of both sexes were taken on iron railings between Croydon and Addington, Surrey.

Lethia humilis (Bl.), 1855.

1855. *Ciniflo humilis*, Bl., *Ann. Mag. N. H.*
1861. ,, ,, ,, *Spid. G. B. I.*
1869. *Lethia varia*, Menge, *Preuss. Spin.*
1879. ,, *humilis*, Camb., *Spid. Dorset.*

Males of this species occurred at Bexhill towards the end of May, but not at all commonly.

Family DRASSIDAE.

Gnaphosa sylvestris (Bl.), 1833.

1833. *Drassus sylvestris*, Bl., *Lond. Edin. Phil. Mag.*
1861. ,, ,, ,, *Spid. G. B. I.*
1875. ,, *criminalis*, Camb., *Ann. Mag. N. H.*
1879. ,, ,, ,, *Spid. Dorset.*
1881. ,, *infuscatus*, ,, ,, ,,
1881. ,, *sylvestris*, ,, ,, ,,
1900. ,, ,, ,, *List Brit. Irish Spid.*

Males of this uncommon species were found running on sandy paths in hot sunshine in Bexhill High Woods during the last week of May.

Prosthesima subterranea (C. L. K.), 1833.

? 1763. *Aranea petiverii*, Scop., *Ent. Carn.* (*ad part.*).
1833. *Melanophora subterranea*, C. L. K., *Die Arach.*
? 1861. *Drassus ater*, Bl., *Spid. G. B. I.*
1879. *Prosthesima petiverii*, Camb., *Spid. Dorset.*
1900. ,, ,, ,, *List Brit. Irish Spid.*

Males of this species occurred at Hastings and Bexhill. They appear, however, to correspond with the figure of *P. apricorum* in *Aran. Hungariae* rather than with that stated to represent *P. subterranea* in the same work.

Family CLUBIONIDAE.

Micaria scintillans (Camb.), 1871.

1871. *Drassus scintillans*, Camb., *Trans. Linn. Soc.*
1879. *Micaria* ,, ,, *Spid. Dorset.*

A male of this very rare and local species was taken on St. Leonard's shore in June.

Agroeca inopina (Camb.), 1886.

1886. *Agroeca inopina*, Camb., *Proc. Dors. F. Club.*

A female of this rare spider was found by Mr. Frank Morey at Marvel Copse, Isle of Wight, in November, 1907.

Agroeca proxima (Camb.), 1871.

1871. *Agelena proxima*, Camb., *Trans. Linn. Soc.*
1879. *Agroeca* ,, ,, *Spid. Dorset.*

This species occurred very abundantly at St. George's Hill, Weybridge, during the summer months. The male palpus is figured on Plate 25, Fig. 3.

Scotina gracilipes (Bl.), 1859.

1859. *Agelena gracilipes*, Bl., *Ann. Mag. N. H.*
1861. *Drassus praelongipes*, Camb., *Ann. Mag. N. H.*
1861. *Agelena gracilipes*, Bl., *Spid. G. B. I.*
1879. *Liocranum gracilipes*, Camb., *Spid. Dorset.*
1900. *Agroeca gracilipes*, Camb., *List Brit. Irish Spid.*

A female was found under a stone at Shirley, Surrey, on May 23rd.

Scotina celans (Bl.), 1841.

1841. *Agelena celans*, Bl., *Trans. Linn. Soc.*
1861. ,, ,, ,, *Spid. G. B. I.*
1879. *Liocranum celans*, Camb., *Spid. Dorset.*
1900. *Agroeca* ,, Camb., *List Brit. Irish Spid.*

A female was found under a stone at Sanderstead, Surrey, in February.

Family SPARASSIDAE.

Sparassus viridissimus (De Geer), 1778.

1757. *Araneus roseus*, Clk., *Sv. Spindl.* (= ♂) (*pre-Linnean*).
1757. ,, *virescens*, Clk., *Sv. Spindl.* (= ♀) (*pre-Linnean*).
1778. *Aranea viridissima*, De Geer, *Mém.*
1793. ,, *smaragdula*, Fabr., *Syst. Ent.*
1806. *Micromata smaragdina*, Latr., *Gen. Crust. Ins.*
1861. *Sparassus smaragdulus*, Bl., *Spid. G. B. I.*
1861. ,, *ornatus*, Westr., *Ar. Suec.*
1867. ,, ,, Bl., *Ann. Mag. N. H.*
1881. *Micrommata virescens*, Camb., *Spid. Dorset.*
1900. ,, ,, ,, *List Brit. Irish Spid.*
1907. *Sparassus viridissimus*, F. P. S., *Journ. Quekett Club*

Specimens of this lovely species, of the female sex, but almost all immature, were seen in the Bexhill Woods during the first week of June.

Family PHILODROMIDAE.

Tibellus oblongus (Walck.), 1802.

1802. *Aranea oblonga*, Walck., *Faune Par.*
1833. *Philodromus trilineatus*, Sund., *Sv. Ak. Handl.*
1861. ,, *oblongus*, Bl., *Spid. G. B. I.*
1881. *Tibellus oblongus*, Camb., *Spid. Dorset.*

During the summer months this species occurred very plentifully amongst coarse grass by the side of a road near Oxted, Surrey. It commonly rests upon a dried grass stem with its legs extended anteriorly and posteriorly, and in this position it is most difficult to detect. The movements of the male are very rapid and erratic, rendering capture a matter of considerable difficulty.

Philodromus rufus (Walck.), 1825.

1825. *Philodromus rufus*, Walck., *Faune Franç.*
1850. ,, *clarkii*, Bl., *Ann. Mag. N. H.*
1861. ,, ,, ,, *Spid. G. B. I.*
1879. ,, *pellax*, Herman, *Ungarns Spinnenfauna.*
1881. ,, *clarkii*, Camb., *Spid. Dorset.*
1900. ,, ,, ,, *List Brit. Irish Spid.*

Females of this species were received from Mr. E. Hayward, by whom they were taken in the New Forest.

Family THOMISIDAE.

Xysticus lateralis (Hahn.), 1831.

1831. *Thomisus lateralis*, Hahn., *Die Arach.*
1845. *Xysticus lanio*, C. L. K., *Die Arach.*
1881. ,, ,, Camb., *Spid. Dorset.*
1900. ,, ,, ,, *List Brit. Irish Spid.*

This species occurred in the New Forest during July, both sexes being then adult.

Xysticus sabulosus (Hahn.), 1831.

1831. *Thomisus sabulosus*, Hahn., *Die Arach.*
1861. „ „ Bl., *Spid. G. B. I.*
1881. *Xysticus* „ Camb., *Spid. Dorset.*

A single female taken at Brockenhurst in July.

Family SALTICIDAE.

Neon reticulatus (Bl.), 1853.

1853. *Salticus reticulatus*, Bl., *Ann. Mag. N. H.*
1861. „ „ „ *Spid. G. B. I.*
1861. *Attus frontalis*, Westr., *Ar. Suec.* (♀ only).
1881. *Neon reticulatus*, Camb., *Spid. Dorset.*

A female of this pretty and distinct little spider turned up at St. George's Hill, Weybridge, Surrey, in July. This species appears to be much commoner in the north than in the south of England.

Evarcha blancardi (Scop.), 1763.

1757. *Araneus flammatus*, Clk., *Sv. Spindl.* (*pre-Linnean*).
1757. „ *falcatus*, Clk., *Sv. Spindl.* (*pre-Linnean*).
1763. *Aranea blancardi*, Scop., *Ent. Carn.*
1802. „ *coronata*, Walck., *Faune Par.*
1825. *Attus capreolus*, Walck., *Faune Franç.*
1831. *Salticus abietis*, Hahn., *Die Arach.*
1861. „ *coronatus*, Bl., *Spid. G. B. I.*
1881. *Hasarius falcatus*, Camb., *Spid. Dorset.*
1900. „ „ „ „ „

This beautiful but not uncommon spider was strongly in evidence in the New Forest during the summer and autumn. (Fig. 4.)

Evarcha marcgravii (Scop.), 1763.

1757. *Araneus arcuatus*, Clk., *Sv. Spindl.* (*pre-Linnean*).
1763. „ *marcgravii*, Scop., *Ent. Carn.*
1846. *Euophrys farinosa*, C. L. K., *Die Arach.*
1846. „ *paludicola*, C. L. K., *Die Arach.*
1868. *Attus albo-ciliatus*, Sim., *Monog. Att.*

1876. *Hasarius falcatus*, Sim., *Ar. France* (♀ only).
1881. „ *arcuatus*, Camb., *Spid. Dorset.*
1900. „ „ „ *List Brit. Irish Spid.*

Both sexes of this fine spider occurred in the adult state at Brockenhurst during August.

Myrmarachne formicaria (De Geer), 1778.

1778. *Aranea formicaria*, De Geer, *Mém.*
1825. *Attus formicoides*, Walck, *Faune Franç.*
1837. *Pyrophorus semirufus*, C. L. K., *Uebers.*
1846. *Pyrophorus helveticus*, C. L. Koch, *Die Arach.*
1861. *Salticus formicarius*, Bl., *Sp. G. B. I.*
1881. *S. formicarius*, Camb., *Spid. Dorset.*
1900. *S. formicarius*, Camb., *List Brit. Irish Spid.*
1907. *Toxeus formicarius*, F. P. S., *Journ. Quekett Club.*

Myrmarachne seems to be the correct generic name for this species in preference to *Toxeus*.

Mr. H. Donisthorpe, who has recently taken specimens at Sandown, Isle of Wight, and has kindly communicated the data (August 15th ♀; August 26th ♂ and ♀), tells me that in each instance he found the spider in company with an ant, *Myrmica scabrinodis*, at the roots of *Lotus major*.

Family PISAURIDAE.

Dolomedes fimbriatus (Linn.), 1758.

1757. *Araneus fimbriatus*, Clk., *Sv. Spindl.* (*pre-Linnean*).
1757. „ *undatus*, Clk., *Sv. Spindl.* (*pre-Linnean*).
1758. *Aranea fimbriata*, Linn., *Syst. Nat.*
1758. „ *virescens*, Linn., *Syst. Nat.*
1778. „ *paludosa*, De Geer, *Mém.*
1778. „ *marginata*, De Geer, *Mém.*
1831. *Dolomedes limbatus*, Hahn, *Die Arach.*
1859. „ *ornatus*, Bl., *Ann. Mag. N. H.*
1861. „ *ornatus*, Bl., *Spid. G. B. I.*
1861. „ *fimbriatus*, Bl., *Spid. G. B. I.*
1881. „ *fimbriatus*, Camb., *Spid. Dorset.*

Immature specimens from one of the New Forest "Bogs" were received from Mr. A. E. A. Hayward in August.

Family LYCOSIDAE.

Tarentula carinata (Oliv.), 1789.

1757. *Araneus pulverulentus*, Clk., *Sv. Spindl.* (*pre-Linnean*).
1789. *Aranea carinata*, Oliv., *Ency. Méth.*
1825. *Lycosa graminicola*, Walck., *Faune Franç.*
1834. *Lycosa gastienensis*, C. L. K., *Deuts. Ins.*
1841. ,, *rapax*, Bl., *Trans. Linn. Soc.*
1848. *Tarentula cuneata*, C. L. K., *Die Arach.*
1861. *Lycosa rapax*, Bl., *Spid. G. B. I.*
1881. *Tarentula pulverulenta*, Camb., *Spid. Dorset.*
1900. ,, *pulverulenta*, Camb., *List Brit. Irish Spid.*

This common species occurred plentifully in a very restricted area in Epping Forest, near Chingford, during May. Hitherto I have found it rather rare in the London district.

Tarentula cuneata (Sund.), 1833.

1757. *Araneus cuneatus*, Clk., *Sv. Spindl.* (*pre-Linnean*).
1833. *Lycosa cuneata*, Sund., *Sv. Ak. Handl.*
1834. ,, *clavipes*, C. L. K., *Deuts. Ins.*
1837. ,, *armillata*, Walck., *Ins. Apt.*
1871. ,, *barbipes*, Camb., *Trans. Linn. Soc.*
1881. *Tarentula cuneata*, Camb., *Spid. Dorset.*

Males of this species, easily recognisable by the black and greatly incrassated tibiae of the front legs, were taken during the last week of May and the first week of June at Bexhill, running rapidly on dusty roads at the hottest part of the day.

Tarentula nemoralis (Westr.), 1861.

1848. *Lycosa nivalis*, C. L. Koch, *Die Arach.* (*ad. partem*).
1861. ,, *nemoralis*, Westr., *Ar. Suec.*
1872. *Tarentula meridiana*, Thor., *Rem. on Syn.*
1907. ,, *nemoralis*, F. P. S., *Journ. Quekett Club.*

The discovery of an adult male and an immature female of this species at Bexhill, as recorded in the *Quekett Journal* for November, 1907, induced me to spend the latter half of May of this year in the same locality. The original pair were found in a

tube of spiders collected in the neighbourhood of Bexhill and labelled "under stones," and I was by no means certain as to the exact locality in which they were taken. Turning stones is not, as a rule, a profitable method of searching for *Tarentulae*, they being more frequently captured when running in bright sunshine; and working on these lines, I visited at the hottest part of the day all the likely spots where I had collected the year before. After a week's failure I found on a small waste of dried-up bracken a number of spiders which microscopical examination afterwards showed to be *T. nemoralis*. Both sexes occurred in the adult state and were fairly plentiful, but restricted to a very small area. The spider is an extremely difficult one to capture, as it runs and jumps with great rapidity. It might be easily mistaken, when upon the ground, for a very small specimen of the common *T. carinata*. In alcohol, however, the reddish markings upon the abdomen impart quite a characteristic appearance.

Family ARGIOPIDAE

Aranea cucurbitina typica Linn., 1758.

1757. *Araneus cucurbitinus*, Clk., *Sv. Spindl.* (*pre-Linnean*).
1758. *Aranea cucurbitina*, Linn., *Syst. Nat.*
1763. ,, *frischii*, Scop., *Ent. Carn.*
1767. ,, *octo-punctata*, Linn., *Syst. Nat.*
1775. ,, *senoculata*, Fabr., *Syst. Ent.*
1778. ,, *viridis-punctata*, De Geer, *Mém.*
1864. *Epeira cucurbitina*, Bl., *Spid. G. B. I.*
1881. ,, ,, Camb., *Spid. Dorset.*

Aranea cucurbitina opisthographa, Kulcz., 1905.

1905. *Araneus cucurbitinus opisthographus*, Kulcz., *Bull. Acad. Cracovie.*

Several years ago, whilst preparing a plate of the palpi of the various species of *Aranea*, I took a spider from a tube in my cabinet labelled *Aranea cucurbitina*, and, having made a rough sketch of a palpus, threw the specimen away, it having been somewhat badly mutilated during examination. Shortly after-

wards, having made a similar drawing from another specimen of the same species, I happened to compare the two, and discovered that they exhibited very considerable variation in several minor characteristics. I began to fear that I had thrown away something valuable—new, probably, to the British list; and I at once set to work to collect long series of *A. cucurbitina* and to critically examine the males. My lost specimen was, unfortunately, unlocalised. During 1907, in particular, I made some very extensive collections of *A. cucurbitina* at Hastings and Bexhill, but found nothing amongst them in any way departing from the recognised type. My short stay at Bexhill, during 1908, as previously mentioned, was mainly devoted to hunting *Tarentulae*, but I bottled, in addition, a general assortment of specimens; and, on examining my captures later, discovered a single male which agreed with my long-lost spider, and which turns out to be the subspecies *Aranea cucurbitina opisthographa* of Prof. Kulczynski, new to the British list. During August Mr. Hayward sent me a number of specimens obtained by beating in the New Forest, and amongst these I was fortunate enough to discover further males of this rarity. The female would appear from the original description to be exceedingly like that of *A. cucurbitina typica*, and I can at present give no really tangible distinguishing character for this sex. The European species of the "*cucurbitina*" group of the genus *Aranea* are dealt with very fully by Prof. Kulczynski in "Fragmenta Arachnologica II." (*Bulletin de l'Académie des Sciences de Cracovie*, 1905).

Family THERIDIIDAE.

Asagena phalerata (Panz.), 1801.

1801. *Phalangium phaleratum*, Panz., *Faun. Ins. Germ.*
1802. *Aranea signata*, Walck., *Faune Par.*
1803. ,, *serratipes*, Schrank, *Fauna Boica.*
1831. *Theridium quadri-signatum*, Hahn., *Die Arach.*
1864. *Theridion signatum*, Bl., *Spid. G. B. I.*
1881. *Asagena phalerata*, Camb., *Spid. Dorset.*

A female of this very rare species was taken by Mr. W. Pinkerton, at Watford.

Family LINYPHIIDAE.

Bathyphantes nigrinus (Westr.), 1851.

1851. *Linyphia nigrina*, Westr., *Goteb. Handl.*
1853. „ *pulla*, Bl., *Ann. Mag. N. H.*
1864. „ „ Bl., *Spid. G. B. I.*
1866. *Bathyphantes terricolus*, Menge, *Preuss. Spin.*
1879. *Linyphia nigrina*, Camb., *Spid. Dorset.*

Bathyphantes pullatus (Camb.), 1863.

1863. *Linyphia pullata*, Camb., *Zoologist.*
1879. „ *pullata*, Camb., *Spid. Dorset.*

The two foregoing species occurred in the Hastings district. The females may be easily distinguished under the microscope by the form of the epigynae. See Figs. 7 and 8.

Porrhomma microphthalmum (Camb.), 1871.

1871. *Linyphia microphthalma*, Camb., *Trans. Linn. Soc.*
1871. „ *decens*, Camb., *Trans. Linn. Soc.*
1878. „ *incerta*, Camb., *Ann. Mag. N. H.*
1879. „ *decens*, Camb., *Spid. Dorset.*
1879. „ *incerta*, Camb., *Spid. Dorset.*
1881. „ *microphthalmum*, Camb., *Spid. Dorset.*
1894. *Porrhomma meadii*, F. Camb., *Ann. Mag. N. H.*

Our member Mr. G. P. Deeley very kindly sent me a number of spiders, apparently of this species, taken in a filter bed at Brierley Hill, Staffs. Collections of *Porrhommae*, especially if they be fairly extensive ones from restricted areas, are particularly welcome, as, without doubt, the genus is one which presents unusual difficulties to the araneologist. Mr. Fred. O. Pickard-Cambridge in *Annals and Magazine of Natural History* for 1894 very thoroughly investigated this genus and created a new species, *P. campbellii*, based upon a single female specimen found in an extensive collection received from Dr. Campbell. Although I have not had the opportunity of examining the type specimen, nor yet to examine the historical collections which Mr. F. Cambridge had at his disposal during his investigations, I hardly feel disposed to accept this species upon the

characters which the author regards as specific. The arrangement of the eyes, their relative size, and their distance from the frontal margin of the caput are all characters which I find particularly unstable in this genus. The form of the abdomen, its colour, and the size of the entire spider are also characteristics which cannot be implicitly trusted for purposes of specific differentiation. I have on more than one occasion met with male specimens typically *microphthalmum* as far as actual structure was concerned, but with the exception that the entire spider, including the palpi, was much below the normal size. Such forms ought probably to be regarded as dwarfed varieties rather than as true species, on exactly the same lines as *Gnaphosa lapidosa* var. *macer*. Until, however, a far larger amount of material than is at present available can be examined, I do not consider it advisable to make any definite alterations in the existing list of admitted *Porrhommae*, and must content myself with remarking that, to my mind, both *P. oblongum* and *P. campbellii* are, as species, extremely weakly defined from *P. microphthalmum*.

The small size of the eyes in this genus, and more particularly their often imperfect structure, is a matter which may be worthy of a few remarks. Many of the earliest examples described were found in caves and coal-mines, and it was promptly suggested that the diminished eyes were due to the influence of the darkness of the creatures' habitat. However true this may be in the matter of caves of considerable geological antiquity, it hardly seems to apply in the case of coal-mines. Besides, specimens taken in meadows near London possess eyes hardly, if at all, larger than the types from the Durham mines. The origin of the spiders in coal-mines is not absolutely certain, but it seems reasonable to suppose that they have been introduced in the horses' fodder. An examination of this commodity, before it is taken down the shaft, will convince one that a very large number of small spiders and insects are concealed in the bundles. Once in the bowels of the earth, and cut off from the normal food supply, the struggle for existence amongst these creatures must be exceedingly keen, and it requires a very small stretch of the imagination to suggest that those species normally possessed of imperfect eyes would more easily adapt themselves to the altered condition than their comrades with well-formed optical

organs, much in the same way as a blind or nearly blind man has the advantage of his fellows during a dense fog. This being so, the application of the generally accepted evolutionary theories would naturally bring us to the present state of things—the survival of the *Porrhommae*. No doubt as time goes on the eyes of these little mine-dwellers will become more and more vestigial, turning to mere pigment patches, and finally disappearing altogether. It is stated on excellent authority that the *Porrhommae* in the coal-mines live together in colonies, and it is not impossible that they find this advantageous in dealing with large and troublesome victims. A small Eresid from South Africa has highly-developed social habits, large numbers of individuals spinning a common web and killing unwieldy victims by concerted attack. By the kindness of Mr. R. Hancock, of Stechford, I had an opportunity of keeping a colony of these remarkable spiders for a considerable time, and was greatly struck by their curious habits. I at once thought of the accounts of the coal-mine *Porrhommae*, and wondered whether their habits were in any way similar. Opportunity, however, has not yet arrived for personal investigation of the matter.

Centromeria bicolor typica (Bl.), 1833.

1833. *Neriene bicolor*, Bl., *Lond. Edin. Phil. Mag.*
1834. *Linyphia comata*, Wid., *Zool. Misc.*
1864. *Neriene bicolor*, Bl., *Spid. G. B. I.*
1879. ,, ,, Camb., *Spid. Dorset.*
1900. *Tmeticus* ,, ,, *List Brit. Irish Spid.*

Centromeria bicolor concinna (Thor.), 1875.

1900. *Tmeticus concinnus*, Camb., *List Brit. Irish Spid.*

Specimens of this species occurred in several localities near London, and opportunities have also arisen for the examination of series taken in the north of England. To my mind the form *concinna* ought to be regarded as a sub-species of *bicolor*. The paracymbium of the male palpus certainly exhibits a very considerable difference if compared in a typical example of each form; but intermediate types are of frequent occurrence, which would seem to preclude our regarding the two as specifically distinct. Well-defined females differ in size, in the armature of

the legs, the position of the eyes, and the height of the clypeus; but all these characters are variable, and intermediate forms are commonly found. The epigynum appears to exhibit no well-marked differential character.

The significance of the terms "variety" and "sub-species" as employed in this and previous papers may need a few words of explanation. We find in the Araneidea numerous instances where certain types cannot be satisfactorily disposed of by the usual binomial system, and where the use of sub-specific and varietal names is conducive to the proper appreciation of the real relationship between the forms in question. Individual specimens are, after all, the only really existent and tangible objects, and as soon as one begins even to group individuals into species one finds that hard-and-fast rules are well-nigh impossible, and that personal opinion must of necessity play an important part in the matter. At the same time a very methodical student must obviously base his work on some system which he can follow, more or less, as his opinion dictates, or as circumstances demand. This being so, it is visibly a great convenience to his *confrères* if he definitely gives some idea of the principle upon which he works instead of imposing upon them the necessity for deducing his methods from his results. In the employment of the terms "species," "sub-species," and "variety," I am quite aware that the criteria for their differentiation must of necessity be almost conventional: still we are dealing with a complex group of animals, and can hardly expect to classify them scientifically and satisfactorily by a simple rule-of-thumb formula.

In cases where two forms occur differing very slightly in the primary sexual characters in one sex (*e.g. Aranea cucurbitina* and *A. opisthographa*) or in the primary sexual characters of one sex and the secondary of the other (*e.g. Philodromus aureolus* and *P. cespiticolis*), and especially where intermediate forms exist, or where, at any rate, both forms are subject to considerable variation, I am inclined to regard them as sub-species and adopt a trinomial system of nomenclature. Several species at present regarded as distinct (*e.g. Erigone dentipalpis* and *E. atra*) could with just as much reason be classified as sub-species.

Where two types identical in sexual structure differ in size,

with or without some additional character of minor importance, especially if intermediate forms exist, I prefer, as a rule, to regard them merely as varieties (*e.g. Gnaphosa lapidosa* and *G. macer*).

Colour variations, without structural characteristics, I regard as a grade decidedly lower in importance than the varietal characters mentioned above, and I have therefore made a practice of using no special naming for the indication of such differences. Obviously one must draw a line somewhere, and however one may be tempted to consider the colour-variety *jejunus* of *Philodromus levipes* worthy of a distinguishing title, the same reasoning pushed a little farther would lead one to encumber the list with three varietal names for *Theridium redimitum*, two each for such species as *Thomisus onustus, Tapinopa longidens, Drapetisca socialis*, and so on.

It must be pretty obvious from these remarks that the keen systematist, who regards consistency as of primary importance, will have many a bitter pill to swallow in dealing with the spiders. There seems to be a total lack of uniformity in the systematic value of certain characters, and those regarded as of primary importance in one group may have to be considered of minor importance in another. The number of the tarsal claws, for example, regarded as of paramount importance in most sections of the order, becomes merely a character of generic value in the family Dysderidae.

The case of *Lophomma subaequalis* and *L. laudatum*, referred to farther on, also furnishes a good example in illustration of the above remarks. The males of these spiders are easily distinguishable by two well-defined characters—the external branch of the palpal tarsus, known as the paracymbium, and a transparent membrane connected with the palpal organs. Apart from these portions of structure the two would probably be inseparable. Take now the case of *Gnaphosa lapidosa* and its variety *cuprea*, another pair consisting of a southern and a northern form. Belonging as they do to a family of a far simpler type, they possess neither a paracymbium nor the transparent membrane above mentioned. Apart from this, however, they possess general characters which make them quite recognisable. Nevertheless, the absence of any tangible morsel of structure which can be exactly described and figured

as an absolute criterion of specific identity forbids the systematist from regarding these two forms as anything more than varieties.

The whole subject, however, from this aspect is an exceedingly involved one, and a very considerable time is likely to elapse ere the various workers will have brought their systems into something like uniformity.

Lessertia, n.g.

General characters as in the "Tmeticus" group.

Both sexes.—Posterior eyes about equidistant. Anterior laterals hardly larger than posterior centrals. Femora without spines above. Tibiae with strong spines above, two each on I., II. and III., one on IV. No metatarsal spines. Sternum considerably longer than broad, produced in an almost parallel-sided elongation between the hind coxae. Falces with well-marked lateral transverse striae (? stridulatory).

Male only.—Maxillae strongly conical near the middle of the under surface. Palpal tarsus at least as long as tibia, which is considerably longer than patella; palpal tarsus broader than tibia, which is broader than patella.

Type, *Lessertia simplex* (F. Camb.), 1892.

In the breaking up of the heterogeneous group of spiders included under the name *Tmeticus*, the species *simplex* seeming to possess characters sufficiently distinct to justify its being regarded as the type of a separate genus, I propose the generic title *Lessertia*.* This genus is closely allied both to *Leptorhoptrum*, Kulcz. and to *Tmeticus*, Menge; the following table will, however, enable one to separate the three without much difficulty.

(*a*) *Both sexes.*

(1) Sternum as broad as long. Spines on tibiae extremely minute, shorter than the diameter of the joint. Falces (at least in male) without definite transverse striae on outer side . . . . . *Tmeticus.*

Sternum considerably longer than broad, produced in a parallel-sided elongation between the hind coxae.

* *Nom. prop.*, in honour of Mons. Roger de Lessert, who is responsible for some very valuable work in connection with the Araneidea of Switzerland.

Spines on tibiae strong or moderately so, at any rate longer than diameter of joint. Falces with well-marked transverse striae on outer side . . (2).

(2) Tibia I. with two spines above and one on inner side. These spines moderately strong, somewhat longer than diameter of joint . . . . *Leptorhoptrum.*

Tibia I. with two spines above, but without any on inner side. Spines strong and about twice as long as the diameter of the joint . . . . *Lessertia.*

(*b*) *Males only.*

(1) Falces each furnished with a powerful tooth-like projection in front, bearing at its extremity and also on its side a strong seta . . . . (2).

Falces without such projections. Tibia of palpus slightly longer than patella and than tarsus . *Leptorhoptrum.*

(2) Patella of palpus abnormally long, furnished, below its anterior extremity, with a conical projection. Tibia as long as patella. Tarsus about half as long as tibia. In breadth patella, tibia, and tarsus practically equal. Maxillae produced conically at anterior exterior angle, also greatly produced at point of insertion of palpus (somewhat as in *Erigone*) . . . . *Tmeticus.*

Patella of palpus normal. Tibia considerably longer than patella. Tarsus at least as long as tibia. Tarsus broader than the tibia which is broader than the patella. Maxillae furnished on inferior surface with a strong conical projection, otherwise normal . . . . *Lessertia.*

Lessertia simplex (F. Camb.), 1892.

1892. *Tmeticus simplex*, F. Camb., *Ann. Mag. N. H.*
1900. ,, ,, Camb., *List Brit. Irish Spid.*

Specimens of this local rarity were kindly sent to me by Mr. G. P. Deeley from Brierley Hill, Staffs. They were taken in a dry filter-bed in company with *Porrhomma microphthalmum.*

Oedothorax gibbosus (Bl.). 1841.

1841. *Neriene gibbosa*, Bl., *Trans. Linn. Soc.*
1841. ,, *tuberosa*, Bl., *Trans. Linn. Soc.*
1864. ,, *gibbosa*, Bl., *Spid. G. B. I.*
1864. ,, *tuberosa*, Bl., *Spid. G. B. I.*
1879. ,, *gibbosa*, Camb., *Spid. Dorset.*
1879. ,, *tuberosa*, Camb., *Spid. Dorset.*
1900. *Gongylidium gibbosum*, Camb., *List Brit. Irish Spid.*
1900. ,, *tuberosum*, Camb., *List Brit. Irish Spid.*
1904. *Oedothorax gibbosus*, F. P. S., *Journ. Quekett Club.*
1904. ,, *tuberosus*, F. P. S., *Journ. Quekett Club.*

This small but striking species occurs not uncommonly in one restricted area in Epping Forest. Invariably associated with it is the spider known as *Oedothorax tuberosus* (Bl.). A very careful examination of extensive series of specimens of *O. gibbosus* and *O. tuberosus* has led me to the conclusion that their claim to being distinct species is very doubtful. In each of several collections made in Epping Forest the proportion of *gibbosus* to *tuberosus* was about equal. The females were numerically about equal to the sum total of the males, but the most critical examination failed to reveal any characteristic by means of which they might be separated into two species or varieties. The epigynum is very constant in form, differing slightly, but distinctly, from that of *O. fuscus* or of *O. retusus*. It is, however, of very simple structure, and would be less likely therefore to exhibit any considerable variation. In fact, it could with some reason be argued in support of the specific distinctions of *gibbosus* and *tuberosus* that the females are indistinguishable purely by reason of the simplicity of their structure.

At first glance, the two forms of male appear totally different. In *gibbosus* the cephalo-thorax is strongly elevated near its centre, forming a very distinct, obtusely rounded eminence. The anterior side of this eminence is deeply excavated, the cavity being covered with a plentiful supply of blackish hairs. In *tuberosus* the eminence is of somewhat similar form, but lacks the characteristic excavation in front. The difference is a striking one, and I have never met with a form which could be regarded as absolutely intermediate. On the other hand, the palpal organs appear to be absolutely identical in the two types.

Taking everything into consideration, I prefer to treat these two forms as specifically identical, regarding *tuberosus* as a dimorphic form of male, but not in any way as a subspecies or variety.

In the specimens I have been able to examine there was but little variation in the typical *gibbosus* male, whereas in the form *tuberosus* the cephalo-thorax varied in shape to a considerable extent.

Oedothorax apicatus (Bl.), 1850.

1850. *Neriene apicata*, Bl., *Ann. Mag. N. H.*
1851. *Erigone gibbicollis*, Westr., *Goteb. Handl.*
1859. *Micryphantes tuberculatus*, Grube, *Verz. Arach. Liv. Kur. Ehstl.*
1864. *Neriene apicata*, Bl., *Spid. G. B. I.*
1867. *Micryphantes gibbus*, Ohl., *Ar. Prov. Preuss.*
1879. *Neriene apicata*, Camb., *Spid. Dorset.*
1900. *Gongylidium apicatum*, Camb., *List Brit. Irish Spid.*
1904. *Stylothorax apicatus*, F. P. S., *Journ. Quekett Club.*

Specimens occurred pretty freely at Hastings and also at South Norwood, Surrey.

Lophomma subaequalis (Westr.), 1851.

1851. *Erigone subaequalis*, Westr., *Goteb. Handl.*
1871. *Walckenaera fortuita*, Camb., *Trans. Linn. Soc.*
1879. ,, *subaequalis*, Camb., *Spid. Dorset.*
1900. *Tapinocyba subaequalis*, Camb., *List Brit. Irish Spid.*
1906. *Lophomma subaequalis*, F. P. S., *Journ. Quekett Club.*

Lophomma laudatum (Camb.), 1881.

1881. *Walckenaera laudata*, Camb., *Spid. Dorset.*
1906. *Lophomma laudatum*, F. P. S., *Journ. Quekett Club.*

In the *Quekett Journal* for November, 1907, I recorded under the name *Lophomma subaequalis* a number of spiders taken at Hastings. A careful comparison with North of England specimens has convinced me that these Hastings examples really belong to the allied species *L. laudatum.* The two species are extremely similar in form and structure, so much so that it has been suggested that they are identical, with a slight dimorphism

in the female. Even were the males inseparable, however, I should be very unwilling to regard the females as dimorphic forms of a single species, seeing that one is typically a northern and the other a southern form. Dimorphism ought, to my mind, to be admitted only where, as in the case of *Oedothorax tuberosus* and *gibbosus* and *Troxochrus scabriculus* and *cirrifrons*, the two forms almost invariably occur together. In the present case, however, a careful examination of the male palpi will show small but sharply defined and apparently quite constant differences, particularly in the paracymbium (the modified outer branch of the tarsal joint) and slightly in the transparent membrane connected with the palpal organs (Figs. 5 and 6).

Entelecara acuminata (Wid.), 1834.

1834. *Theridion acuminatum*, Wid., *Zool. Misc.*
1863. *Walckenaera altifrons*, Camb., *Zoologist.*
1879. " " Camb., *Spid. Dorset.*
1906. *Entelecara acuminata*, F. P. S., *Journ. Quekett Club.*
1907. " " F. P. S., *Journ. Quekett Club.*

This species occurred at Bexhill in enormous numbers during the last week of May and the first week of June. The iron railings surrounding the cemetery at Clinch Green were so thickly populated that hardly a crevice could be found which did not contain a female, generally with a male in the near vicinity. In order to make a typical gathering I collected as far as possible every specimen upon a ten-foot extent of railing—yet in less than half an hour their places had been taken by new arrivals, so much so that I was unable to decide exactly where the collection had been made. The spiders were not using the railings as a position of vantage from which to embark on an aërial excursion, but had built their tiny snares there. Curiously enough, I did not see, amongst the thousands of webs, a victim of any sort, and I was rather perplexed to know whence the sustenance of the owners was derived. Very possibly the clouds of tiny diptera which appeared at dusk supplied the deficiency. At any rate the spiders were plump and apparently well fed, and the males were courting their mates with an earnestness not in the least suggestive of hard times. The epigynum of this species is figured on Plate 25, Figs. 9, 10, 11, the drawings, which show three typical variations, being made from recently killed specimens.

Entelecara erythropus (Westr.), 1851.

1851. *Erigone erythropa*, Westr., *Goteb. Handl.*
1862. *Walckenaera borealis*, Camb., *Zoologist.*
1879. ,, *erythropa*, Camb., *Spid. Dorset.*
1906. *Entelecara erythropus*, F. P. S., *Journ. Quekett Club.*
1907. ,, ,, F. P. S., *Journ. Quekett Club.*

The epigynum of this species is illustrated (Figs. 12, 13), two variations from recently killed specimens being shown.

Entelecara trifrons (Camb.), 1863.

1863. *Walckenaera trifrons*, Camb., *Zoologist.*
1879. ,, ,, Camb., *Spid. Dorset.*
1906. *Entelecara trifrons*, F. P. S., *Journ. Quekett Club.*

The epigynum of this species is figured on Plate 25, Fig. 14, for comparison with the two foregoing. The specimen from which the drawing was made has been preserved for some years in alcohol, and appears to be slightly shrunken.

Troxochrus scabriculus (Westr.), 1851.

1851. *Erigone scabricula*, Westr., *Goteb. Handl.*
1860. *Walckenaera aggeris*, Camb., *Ann. Mag. N. H.*
1864. ,, ,, Bl., *Spid. G. B. I.*
1871. ,, *cirrifrons*, Camb., *Trans. Linn. Soc.*
1879. ,, *scabricula*, Camb., *Spid. Dorset.*
1881. ,, *cirrifrons*, Camb., *Spid. Dorset.*
1906. *Troxochrus scabriculus*, F. P. S., *Journ. Quekett Club.*
1906. ,, *cirrifrons*, F. P. S., *Journ. Quekett Club.*

This species absolutely swarmed during the winter under some haystacks near Croydon. Extensive collections were made, and the opportunity taken of comparing these specimens with others from the north of England. The result of this examination has been to convince me that, in spite of the fact that I have never been able to find actual connecting links, the two male forms, *scabriculus* and *cirrifrons*, ought to be regarded as dimorphic modifications of one species rather than as specifically distinct. In every collection sufficiently extensive to yield trustworthy statistical data these two male forms occurred in fairly constant proportions. The females taken with these were about

numerically equivalent to what we should expect to find as the complement to the combined males, estimating the proportion of males to females on the averages of a number of allied species. The most critical examination, however, failed to indicate any character which could be employed in separating the females into two groups. The form of the caput of the male, which seems to be the only tangible distinction between these two types, ought not, in my opinion, to be too slavishly followed as a criterion of specific value. I have carefully examined the male palpi in both forms, and their structure appears absolutely identical.

Explanation of Plate 25.

Fig. 1. Epigynum, *Ciniflo similis*, × 45.
,, 2. ,, ,, *fenestralis*, × 45.
,, 3. Palpus, *Agroeca proxima*, × 45.
,, 4. Epigynum, *Evarcha blancardi*, × 90.
,, 5. Palpus, *Lophomma subaequalis*, × 90.
,, 6. ,, ,, *laudatum*, × 90.
,, 7. Epigynum, *Bathyphantes nigrinus*, × 90.
,, 8. ,, ,, *pullatus*, × 90.
,, 9, 10, 11. Epigynum, *Entelecara acuminata*, three variations, × 180.
,, 12, 13. ,, ,, *erythropus*, two variations, × 180.
,, 14. ,, ,, *trifons*, × 180.

NOTE ON THE ROTATORIAN FAUNA OF BOSTON, WITH DESCRIPTION OF NOTHOLCA BOSTONIENSIS, s. n.

By Charles F. Rousselet, F.R.M.S.

(*Read October 2nd*, 1908.)

Plates 26 and 27.

In August of last year I had the honour of attending, as the delegate of the Quekett Microscopical Club, the Seventh International Zoological Congress in the United States of America. The members of the Congress, from all parts of the world, assembled on August 19th, 1907, at Boston, where they were most hospitably received and entertained by the American zoologists and local men of science, and in particular by the staff of Harvard University, in whose new Medical School the meetings of the Congress were held.

During a week's stay in Boston I examined the water of the ornamental lake in the very pretty Central Park, and finding it rich in Rotifera I filled two bottles with condensed and preserved material from this lake and from the "Frog Pond" close by, for future study.

The result of the examination of this material has brought to light forty different species of free-swimming Rotifera, one of which, *Notholca bostoniensis*, is new to science; another, a free-swimming *Oecistes*, probably also new, but not sufficiently well preserved to be determined with certainty, and several rare and interesting species which have been met with only once before.

The following is the list of species collected on Friday, August 23rd, 1907:

Rhizota.

Floscularia mutabilis, Bolton.
Oecistes (sp. ?), free-swimming.
Conochilus unicornis, Rouss.

Bdelloida.

Some *Bdelloida*, contracted and not recognisable.

Ploima. Il-loricata.

Synchaeta longipes, Gosse, abundant.
,, *pectinata*, Ehrenbg.
,, *cecilia*, Rouss.
,, *oblonga*, Ehrenbg.
,, *stylata*, Wierz.
Triarthra longiseta, Ehrenbg.
Polyarthra platyptera, Ehrenbg.
,, *aptera*, Hood.
Notommata ansata, Ehrenbg.
Diglena forcipata, Ehrenbg.
Taphrocampa viscosa, Levander.
Proales daphnicola, Thompson.
,, *petromyzon*, Ehrenbg.

Ploima. Loricata.

Rattulus bicristatus, Gosse.
,, *rattus*, Ehrenbg.
,, *cylindricus*, Imhof.
,, *longiseta*, Shrank.
Diurella insignis, Herrick.
,, *stylata*, Eyfert.
,, *tenuior*, Gosse.
Diaschiza gibba, Ehrenbg.
Dinocharis pocillum, Ehrenbg.
Polychaetus subquadratus, Perty.
Euchlanis hyalina, Hudson.
Hudsonella pygmaea, Calman.
Cathypna rusticola, Gosse.
Ploesoma lenticulare, Herrick.
Metopidia rhomboides, Gosse.
,, *lepadella*, Ehrenbg.
,, *acuminata*, Ehrenbg.
Monostyla lunaris, Ehrenbg.
Pterodina parva, Ternetz.

Brachionus pala, Ehrenbg.
Anuraea cochlearis, Gosse.
Notholca longispina, Kellicot.
,, *bostoniensis*, sp. nov.

Notholca bostoniensis, sp. nov.

The most noteworthy rotifer found at Boston is this new species of Notholca. A glance at the figures on Plate 26 will show that it has considerable resemblance to *Notholca longispina* of Kellicot, a well-known and widely distributed species, but a closer examination will reveal important differences in the structure of the lorica.

Notholca longispina, which was also present in the same lake, reaches 720 μ ($\frac{1}{35}$ in.) in size, has six occipital spines—namely, a lateral pair of equal size, a dorsal asymmetric pair having a very long spine on the *right* side of the median line and a very short straight spine on the *left* side, and a further pair of small spines, one on each side between the dorsal and lateral pairs.

The new species, *Notholca bostoniensis*, is altogether much smaller in size, just one-half in total length, and has only four occipital spines—namely, two equal small lateral spines and a dorsal asymmetric pair, with the very long and stronger spine on the *left*, and the short one on the *right* of the median line. The three small occipital spines are nearly equal in size. On Plate 27 I have reproduced figures of both species, *N. bostoniensis* and *longispina*, drawn to the same scale to emphasise these differences.

The occipital spines of *N. bostoniensis* taper to a fine point and show at regular intervals very fine notches, which appear to run spirally round the spines. Posteriorly the lorica tapers into a long, nearly straight spine which is quite smooth and free from notches.

The body of the *lorica* is smaller but distinctly more swollen in the middle, and less triangular in form than that of *longiseta*. The mental edge is undulate with a notch in the centre.

My first impression when seeing these small long-spined Notholca swimming in considerable numbers in the water was that they were young and newly hatched specimens of *N. longispina*, which appeared like giants, twice as great in length,

in the same water; but the subsequent discovery of the characteristic differences in the structure of the lorica obliges me to give it a new specific name. Moreover, a number of the examples were carrying an egg on the postero-ventral side, showing that they are mature animals.

The internal anatomy was not specially studied, but appears to be normal and the same as in other species of the genus.

The specific diagnosis of *Notholca bostoniensis* may be expressed as follows:

Lorica ovoid, greatly produced behind into a long spine; four occipital spines, the *left* median spine very long, the other three small, of about equal size.

Total length of lorica, 360 μ ($\frac{1}{71}$ in.); long anterior spine, 136 μ ($\frac{1}{186}$ in.); posterior spine, 122 μ ($\frac{1}{210}$ in.).

Oecistes, sp. ?

In the same water I observed a free-swimming tube-dweller of the genus *Oecistes*, which is unlike any species that I am acquainted with or that I have seen described. Unfortunately my observations were too hurried, and the preservation *en bloc* of the material did not produce sufficiently well-preserved and expanded specimens to enable me to give a good description of it.

The animal inhabits a tube perfectly cylindrical in shape, open at the anterior end, and rounded and closed posteriorly, 340 μ ($\frac{1}{75}$ in.) long and 75 μ ($\frac{1}{340}$ in.) wide. The anterior two-thirds of the tube is semi-opaque by being covered with brown material in the form of rodlets; the density of the material diminishes posteriorly, leaving the posterior third of the tube quite clear.

Of the corona of the rotifer inhabiting this tube I can only say that it is nearly circular with a well-marked notch on the ventral side. Two fairly long cylindrical ventral antennae were readily seen in contracted specimens. The body of the *Oecistes* is 238 μ ($\frac{1}{107}$ in.) long when partially contracted, cylindrical, tapering posteriorly into a short foot, which appears always fixed to a short, thin, rigid stalk 54 μ ($\frac{1}{470}$ in.) long, the posterior end of which lies free in the tube. Two red eyes, wide apart on the corona, were observed.

This being all the description I can give of this probably new

species, I prefer not to give it a name. Perhaps some member of the Boston Society of Natural History may look for it and supply a good description and figure.

It might be suggested that this *Oecistes* may have been fixed and knocked off its support: but as I did not take up any weed, and found quite a score of specimens in the material collected with the plankton net, and, moreover, saw animals freely swimming in a micro-trough under the microscope, I do not think I am in error in considering this a free-swimming form. We have several free-swimming Floscules, and therefore there seems no reason why an *Oecistes* should not take to a free and roving life.

The following other species of Rotifera found in this collection may be specially mentioned:

Pterodina parva, characterised by the peculiar pear-shaped lorica, was found only once before by Dr. Ternetz, near Bâle, in Switzerland; his figure enabled me to recognise it without difficulty. In my paper on "Some Little-known Species of Pterodina,"* I have reproduced Dr. Ternetz's figure, but most unfortunately a serious error has crept into this copy. The foot is there indicated as if issuing from near the middle of the lorica, whilst the position of the opening is near the posterior margin on the ventral side. Dr. Ternetz's drawing is perfectly correct, and, as a figure is always remembered better than a description, I have reproduced a correct figure of this rare Pterodina on Plate 27, Fig. 6.

The size of *Pterodina parva* is 99 μ ($\frac{1}{256}$ in.) long by 95 μ ($\frac{1}{267}$ in.) wide.

Taphrocampa viscosa is a rare species, found before only in Finland by Dr. Levander.

Polychaetus subquadratus, *Ploesoma lenticulare*, *Polyarthra aptera* are all three rare and not often seen.

Synchaeta.—Five species of the genus were readily recognised: *S. pectinata* and *oblonga* are common everywhere, but *longipes*, *stylata*, and *cecilia* are rather rare.

In the afternoon of August 22nd the members of the Zoological Congress were hospitably received at Wellesley College, a Ladies' University near Boston, in the extensive and beautiful

* *Journ. Quekett Micr. Club*, vol. vii. (1898) pp. 24-30.

grounds of which there is a large lake covering many acres. Rowing out on this lake, I made a collection with the condensing net, but on examination at home obtained therefrom only the following six species of Rotifera :

Floscularia mutabalis, Bolton.
Polyarthra platyptera, Ehrenbg.
Diurella stylata, Eyfert.
Rattulus cylindricus, Imhof.
Monostyla lunaris, Ehrenbg.
Anuraea cochlearis, Gosse.

No doubt a closer examination of various parts of this lake, and at various seasons, would bring to light a much greater number and variety of Rotifera.

Explanation of Plates 26 and 27.

Fig. 1. *Notholca bostoniensis*, sp.n., lateral view, × 425.
,, 2. ,, ,, dorsal view, × 425.
,, 3. ,, ,, ventral view, × 425.
,, 4. ,, ,, lateral view, × 220.
,, 5. ,, *longispina*, dorsal view, × 220.
,, 6. *Pterodina parva* (Ternetz's figure), × 575.

NOTICES OF BOOKS, ETC.

Mosses and Liverworts. By T. H. Russell, F.L.S. $5\frac{1}{2} \times 8\frac{1}{2}$ in. 200 + ix. pages, 10 plates, and coloured frontispiece. London, 1908. Sampson Low, Marston & Co., Ltd. Price 4*s.* 6*d.* net.

The appearance of an unpretentious work dealing with mosses and hepatics, and practically devoid of technical terms, strikes one rather as a novelty. The above artistic little volume is certainly calculated to arouse enthusiasm in the subject with which it deals, this being a remark which we should be very chary of making with regard to the majority of works dealing with cryptogams. It professes to be nothing more than an introduction, but it is a sound and thorough one, and eminently practical. The chapter on the collection and preservation of specimens is particularly useful. Unlike most specialists the author seems to be extremely particular in the matter of the perfection and "finish" of his slides, regarding air-bubbles as veritable bogies and sparing no pains to get rid of them. We are rather surprised that he does not advocate the use of the air-pump, which will generally induce even the smallest and most artfully concealed bubble to reveal its whereabouts. *Mosses and Liverworts* ought to have decidedly beneficial influence in popularising the study of its title-subject, and we wish it success.

F. P. S.

Les Diatomées Marines de France et des Districts Maritimes Voisins. By MM. H. and M. Peragallo. 560 pages, 139 plates, some coloured, comprising 2,187 figures. J. Tempère, Micrographe-Éditeur, à Grez-sur-Loing (S.-et-M.). Price £6.

To recommend a work of this kind to a diatom enthusiast is somewhat upon a par with recommending nuts to a monkey. Perhaps, however, we may be justified in mentioning its existence

in these pages, lest, perchance, some student of this interesting group of organisms may have overlooked the fact that the work referred to is one which he certainly cannot afford to be without. The names of the authors and the publisher are themselves sufficient guarantee both of the accuracy of the subject-matter and the technical perfection of the letterpress and plates, and in offering our congratulations on the appearance of such a work we feel we are only echoing the sentiments of all who are in any way interested in the welfare of the study of the Diatomaceae.

F. P. S.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on January 27th, 1908, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on December 20th, 1907, were read and confirmed.

Messrs. C. C. Dallas, C. C. Pattison, A. Nicholson, A. E. Levin, and T. G. Cooling were balloted for and duly elected members of the Club.

Nominations for officers and council for the ensuing session were taken. Professor E. A. Minchin, M.A., Professor of Protozoology in the University of London, was nominated as President.

The Hon. Secretary regretted to announce that both Mr. W. Wesché and Mr. Rosseter, who had promised papers for this meeting, were prevented by illness from being present.

The President drew attention to the exhibit by Messrs. Watson of a large number of preparations of insects and insect parts. The thanks of the meeting were accorded to Mr. F. W. Watson Baker, F.R.M.S., for arranging the exhibit.

Messrs. Baker exhibited with the lantern a number of interesting slides, mostly photomicrographs, of pond-life and other low organisms, also one of a section of human scalp, taken on a Lumière autochrome plate, which was much admired.

Mr. E. Large, with the projection polariscope, exhibited on the screen a number of preparations, many of them very beautiful, of thin slices of selenite. Some of the specimens were geometrical patterns artificially made, and were extremely effective, especially when the object or the nicol was rotated. Mr. Large also exhibited a number of photomicrographs of twinned crystals of selenite.

The President said he greatly regretted to have to announce the sudden death of a member who was well known to many of

those present—Mr. Whiting, who had for some time past acted as Assistant Curator, and had proved a great help in that capacity to Mr. Sidwell. He was present at their last meeting, and would have been with them that evening had not the hand of death arrested him. He felt sure it would be the wish of all present that their Secretary should send a letter of condolence to his family.

At the meeting of the Club held on February 21st, 1908, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on January 27th were read and confirmed.

Messrs. J. C. Jackson, Wm. North, E. E. Shorter, and E. Heron-Allan were balloted for and duly elected members of the Club.

On the ballot being taken for officers of the Club and for members of the committee, the chief changes made were: President, Professor E. A. Minchin, M.A. Oxon., and the addition to the list of Vice-Presidents of Mr. H. Morland, for seven years Hon. Treasurer, and of Dr. E. J. Spitta, F.R.A.S., etc., President of the Club, 1904-8. The other officers are as last year. The Hon. Secretary read the forty-second annual report of the committee, which showed a satisfactory state of matters generally. The membership of the Club on December 31st, 1907, was 451, a gain of sixteen over the corresponding date in 1906. The attendance at the ordinary meetings throughout the year had been very good, the highest figure being 131 for the January meeting. The nine excursions for collecting pond-life, etc., were also well attended, the average number of members at each being 19·5. The Hon. Librarian reported that the library had been, as usual, well used by members. One of the chief additions during the year was *Microscopy*, by the President, Dr. Spitta, who had dedicated the work to the Club. The Hon. Curator reported on the Club's cabinet of micro-slides, which had been well taken advantage of by members during the last year. Of the slides added, mention should be made of the generosity of Dr. E. Penard, who has added to his previous donations by completing a type collection of forty-five preparations of Rhizopoda.

The Hon. Treasurer, in his report, stated that, notwithstanding an increased cost of the *Journal*, the balance in hand was rather

more than last year, and he considered the financial position of the Club very satisfactory.

A special vote of thanks was accorded to the Editor of the *English Mechanic* for his courtesy in publishing lengthy reports of the meetings of the Club in the issue of the week following. The reports are much appreciated by members in general, but especially by our country members, who would otherwise have to wait for the publication of the half-yearly *Journal.*

Mr. H. Morland took the chair, and the annual Presidential Address was then delivered by the retiring President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., who took for his subject, "The Photography of Very Translucent Diatoms at High Magnifications."

The usual votes of thanks to the President, auditors, and scrutineers, and committee and officers, were then proposed, seconded, and carried.

The retiring President then introduced Professor E. A. Minchin, the new President, to the meeting.

Professor Minchin made a modest acknowledgment of the honour which he said the Club had paid him, and, while not claiming the title of expert on the microscope itself, hoped that he knew a little more about the use of the instrument than the man who complained of the performance of his oil-immersion objective, and was found to have the notion that the eyepiece should be removed and the tube filled up with oil! He hoped to serve the Club as faithfully as his eminent predecessors.

Mr. W. Imboden, F.R.M.S., exhibited and described an apparatus designed to facilitate the drawing of microscopical low-power objects, the image being projected directly upon a drawing surface, where it can be traced with a pencil in a very convenient and easy way. The apparatus consists in the main of a plate-glass mirror, which is fastened to an extended arm, allowing the distance between the mirror and ocular, and consequently the magnification, to be modified at will without changing the optical combination. An appliance to exclude light, which might impair the brilliancy of the projected image, is used, and, as the nucleus towards success, adequate illumination (a Nernst lamp was used) must be provided. The device gave very excellent results, and no doubling of the image from the mirror was noticeable.

Messrs. R. & J. Beck exhibited an immersion paraboloid for the illumination of bacteria, etc., on a dark ground with high powers.

Mr. W. B. Stokes (Hon. Secretary) exhibited and described a cheap silvered side-reflector. A shilling biconvex lens of 6 in. focus was cut in half, and one curved surface of each half was silvered. Each semicircle provided an efficient side-reflector at a nominal cost.

At the meeting of the Club held on March 20th, 1908, Professor E. A. Minchin, M.A., President, in the Chair, the minutes of the meeting held on February 21st were read and confirmed.

Messrs. F. C. Croger, D. C. Wingate, A. C. Banfield, J. C. West, and B. Blackbourn were balloted for and duly elected members of the Club.

The Hon. Editor, Mr. F. P. Smith, exhibited under a microscope a preparation showing the formation of a new claw in spiders. In describing the object, he said that, when moulting, the spider sheds the claw as well as the whole skin. He had searched for a really good specimen of this object for a number of years, but there was a good deal of luck in obtaining it. The best way to secure such was to take a spider with a very transparent skin but very dark claws, and wait; or, better, of course, take a large number—he would recommend specimens to be bred from the same batch of eggs—and watch the moulting. As soon as one specimen was observed to be moulting another individual from the same batch should be taken and held by a single leg. This would, as likely as not, be thrown off, and had simply to be treated with potash, dehydrated, flattened, and mounted in balsam. If not satisfactory, take another leg, and try again.

Mr. A. E. Hilton read a most interesting paper on "The Cause of Reversing Currents in Plasmodia of Mycetozoa."

Mr. C. D. Soar, F.R.M.S., read a paper on the genus *Hydrachna*, illustrated by drawings of all the twenty-one British species, and also a chart showing the specific differences in the dorsal plates.

At the meeting of the Club held on May 15th, 1908, Professor E. A. Minchin, M.A., President, in the Chair, the minutes of the meeting held on March 20th were read and confirmed.

Messrs. T. Hiscott, P. J. Bunting, and J. H. East were balloted for and duly elected members of the Club.

Mr. C. Lees Curties, F.R.M.S., exhibited and described the simple form of Apertometer suggested by Mr. F. J. Cheshire, F.R.M.S., and figured and described in the *Journal Q.M.C.*, Ser. II. Vol. IX., p. 1, 1904. The readings obtainable are accurate within N.A. 0·05. The form of the instrument shown has just been placed on the market by Messrs. Baker. Mr. Curties also described a form of mercury-vapour lamp adapted for use as an illuminant for microscopy. A microscope was shown having on one side a mercury-vapour lamp, and on the other side an ordinary oil lamp. Using light from the oil lamp, the object, *A. pellucida*, was resolved into lines; but, on adjusting the mirror to receive light from the mercury-vapour lamp, the diatom was shown well "dotted." The form of lamp shown, which, it was understood, would shortly be placed on the market, was adjusted to take direct current $\frac{1}{2}$ ampère at 100 or 200 volts.

Mr. W. B. Stokes (Hon. Secretary) wished that the mercury-vapour lamp was generally available, as it would simplify matters very much. We should have no secondary spectrum to worry us, and objectives corrected for a few wave-lengths only could be made at very much less cost than those now in use.

Mr. R. T. Lewis, F.R.M.S., exhibited and described a number of very beautiful preparations of insects, chiefly of those of brilliant colouring. One of the most striking was a specimen of the rare *Isthmia patruelis* (Homoptera) from Natal. An instance of protective mimicry was shown in *Phyllomorpha laciniata* (Hemiptera Heteroptera), also from Natal (it is found on a lichen, to which it bears a remarkable colour resemblance); and a series of four preparations, which, Mr. Lewis said, would remind old members of a long controversy, about the end of the "sixties," as to where certain hairs came from! These were the hairs known as "of the larva of *Dermestes*." He had proved them to be derived from the pupa of *Anthrenus museorum*, and also from the larva of *Tiresius serra*.

The President exhibited some preparations of spicules of calcareous sponges showing the axial filaments stained. In describing them, he said that the presence of a thread of organic matter in the axial canal of siliceous sponge spicules had been

frequently and easily demonstrated. The thread could be isolated by dissolving away the silica with hydrofluoric acid. In the case of calcareous sponges, we should expect to find similar structure; but there had been great uncertainty as to the existence of such a filament. Indeed, it had been definitely stated by eminent authorities that it did not exist. However, he had recently been able to demonstrate the existence of this filament, and a preparation was exhibited under a microscope then on the table. The spicule had been decalcified and then stained with nigrosine, induline, or picric or nitric acid and nigrosine. As would be seen on inspection, the stain had not only affected the known sheath, but also the central organic filament.

The thanks of the meeting were returned to the various exhibitors, and also to Messrs. Baker for their kindness in providing the microscopes used.

Mr. F. Martin-Duncan, F.R.P.S., gave a lecture, very fully illustrated with lantern photographs, dealing with interesting points in Insect Life. He said that the study of insect life was a branch of natural science which was growing very greatly in importance. Referring to the photographs he was about to show to the meeting, he said that he had tried all the three-colour processes as they came out, and, while one could get very good renderings of pure colours, one could not get at all satisfactory results in dealing with subtle half-tones and gradation of colours. But in the process brought out by Messrs. Lumière, of which he was about to show a few specimens, one did get these delicate grades of colour well reproduced, at any rate, to a very large degree. One very great drawback to the employment of the Autochrome plates was their extreme slowness. Even in the field, the minimum exposures he had been able to give were two or three seconds, and an insect, for instance, can move considerably in that time. An interesting set of photographs illustrating the fertilising of the early orchid by the bee was shown, and fully described. Mr. Martin-Duncan also told the meeting how a spider which has a coloration very like a flower-bud takes up a position on the upper part of the flower-stalk, and, on a bee alighting on one of the opened flowers just below, springs down and secures its victim, retiring among the lower flowers to enjoy its meal.

After the early orchids have all gone, the spider goes to the meadow thistle and lives among the florets. Dealing with bees, the lecturer said he had a great number, and, until recently, was able to handle them with impunity; but last year whilst photographing some bees belonging to a friend he had the misfortune to be badly stung. The curious part was that, when he had recovered and visited his own bees for the first time after the occurrence, he heard their danger-note, and they promptly attacked him. Some subtle change had taken place in him, and he had become an object of intense dislike, and was no longer able to approach even near his own hives. Photographs were shown of the old-fashioned wasteful "skep" and the modern frame hives, and of "foundations" with bees at work on them. One of the brood-comb showed workers busy, some young bees emerging, and also included the queen. Some photomicrographs of parts of the bee and wasp were shown, and the adaptation of the mouth-parts in each described and compared. The mole-cricket next claimed attention. It is an interesting creature in many ways, but is rather difficult to obtain. It leads a subterranean life, and only comes out at dusk. Its note is curiously ventriloquial, in that it sounds quite far away while it may actually be at one's feet. The larvae of the Puss moth and the combative habits of the Lobster moth larva were dealt with, and were followed by a very interesting series of photographs illustrating the emergence of a butterfly from the pupa-case. An autochrome slide of the fully developed insect, a Peacock butterfly, was shown. This, Mr. Martin-Duncan said, was one of six attempts to get a satisfactory photograph, the others being spoilt through movement during the necessary comparatively long exposure. The "eye" markings on wings were then noticed, and a number of interesting photographs, including several autochromes, were projected. The lecturer quoted instances where he had placed Purple Emperors in an aviary. So long as the butterfly flew about the birds appeared rather alarmed; but when it settled down, and folded its wings, so covering up the "eyes," it had not much longer to live.

At the meeting of the Club held on June 19th, 1908, Professor E. A. Minchin, M.A., President, in the Chair, the minutes of the meeting held on May 15th were read and confirmed.

Messrs. J. E. Barnard, S. W. Flamank, G. Mitchell, H. V. Knaggs, A. E. Auchley, N. T. Howard, J. H. Bayliffe, and E. E. Banham were balloted for and duly elected members of the Club.

Mr. A. Earland exhibited some twenty-eight preparations of Foraminifera. Some of the more noticeable may be mentioned. A slide illustrating "triple isomorphism," of the imperforate or porcellanous type, *Cornuspira*; arenaceous, *Ammodiscus*; perforate or hyaline, *Spirillina*; a preparation showing isomorphism between an arenaceous and a hyaline form, *Globigerina bulloides*, d'Orb, and *Haplophragmium globigeriniforme*, Parker and Jones. *Rhizammina indivisa*, Brady, from the "cold area" of Faroe Channel, 1,200 metres. This is one of the largest known forms. The shell is built up of other Foraminifera (chiefly *Globigerinae*) and sponge spicules cemented together. A slide of a number of arenaceous forms from all parts of the world, was also exhibited to show the great variety of materials used in the construction of the composite shell or test, and the varying degree of neatness in construction, which is principally due to the greater or less amount of cement used by the organism. *Crithionina pisum*, Göes, var. *hispida*, Flint. The typical form is found in deep water, and builds a pea-shaped test of fine mud and sand. The variety shown incorporates in its test sponge spicules always with the points outwards, as a defensive measure against boring annelids. A specimen of the world-wide form *Ammodiscus incertus*, d'Orb, from North Atlantic, was also exhibited. This species ranges back at least as far as the Carboniferous period. In describing an exhibit of specimens of *Reophax scorpiurus*, Montfort, it was stated that the "material on the spot" was generally used in the construction of the shells of arenaceous forms. The external appearance of individuals of the same species may therefore vary greatly, according to the nature of the surroundings. No sand being procurable, some of the specimens shown had used other Foraminifera. Others from shallow water in the North Sea used sand grains of various sizes, and in one specimen garnets had also been found. In concluding his remarks, Mr. Earland expressed his thanks to

Messrs. Beck and to Messrs. Baker for the loan of the microscopes used.

At the request of the President, Dr. E. J. Spitta said he wished to ask members present to join with him, acting as president of the committee appointed for the purpose, in presenting to their Honorary Librarian, Mr. Alpheus Smith, a small token of the gratitude felt by the members of the Club, and their appreciation of his services in acting as Librarian for the long period of thirty-six years. Unfortunately, Dr. Spitta said, he had had no notice that he was to have this matter placed in his hands, or he would have expended more time in the preparation of his remarks. Mr. Smith was a man peculiarly fitted for the work, and he had, besides, executed his duties in strict conformity to the rules of the Quekett Microscopical Club, and he was quite sure that not one single member could be found to say a word against him. He had very much pleasure in asking Mr. Alpheus Smith to accept a small silver box containing an amount of fifty sovereigns individually subscribed by members. He would ask him to receive it as a memento, and not as a quid pro quo for his services, which could not be given a money value, and he hoped that he would understand that, however small it was as a gift in proportion to his services, great was the sentiment connected with it.

Mr. W. Wesché, F.R.M.S., said he wished to add his testimony to that of Dr. Spitta, and he was very pleased indeed to see this recognition by the Club of Mr. Smith's long and faithful service.

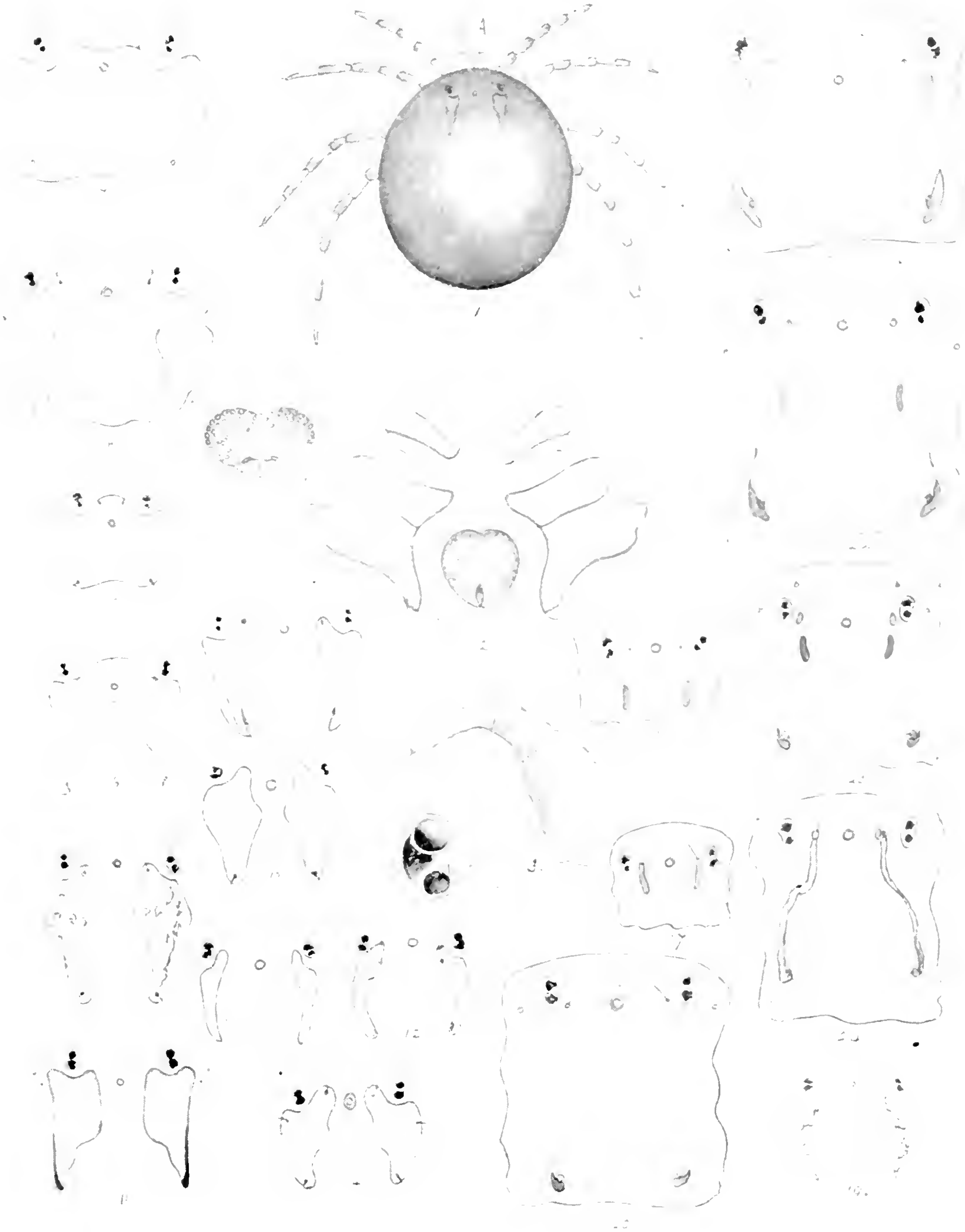
Mr. C. F. Rousselet, F.R.M.S., was very pleased to associate himself with this proposal. When he first came to the meetings of the Quekett Club, some twenty-seven years ago, Mr. Smith was occupying the same position he still held, and he was sure he was voicing the general feeling when he said that he hoped Mr. Smith would occupy it for very many more years.

Dr. Spitta said that he was very pleased indeed to make this presentation. He had as yet but a short acquaintance with the Club; but, even so, was able to appreciate the way their library was kept. He had very much pleasure in asking Mr. Smith to accept the testimonial on behalf of members of the Club.

Mr. Alpheus Smith, who, on rising, was greeted with continued applause, said that it might be of interest to members if he gave

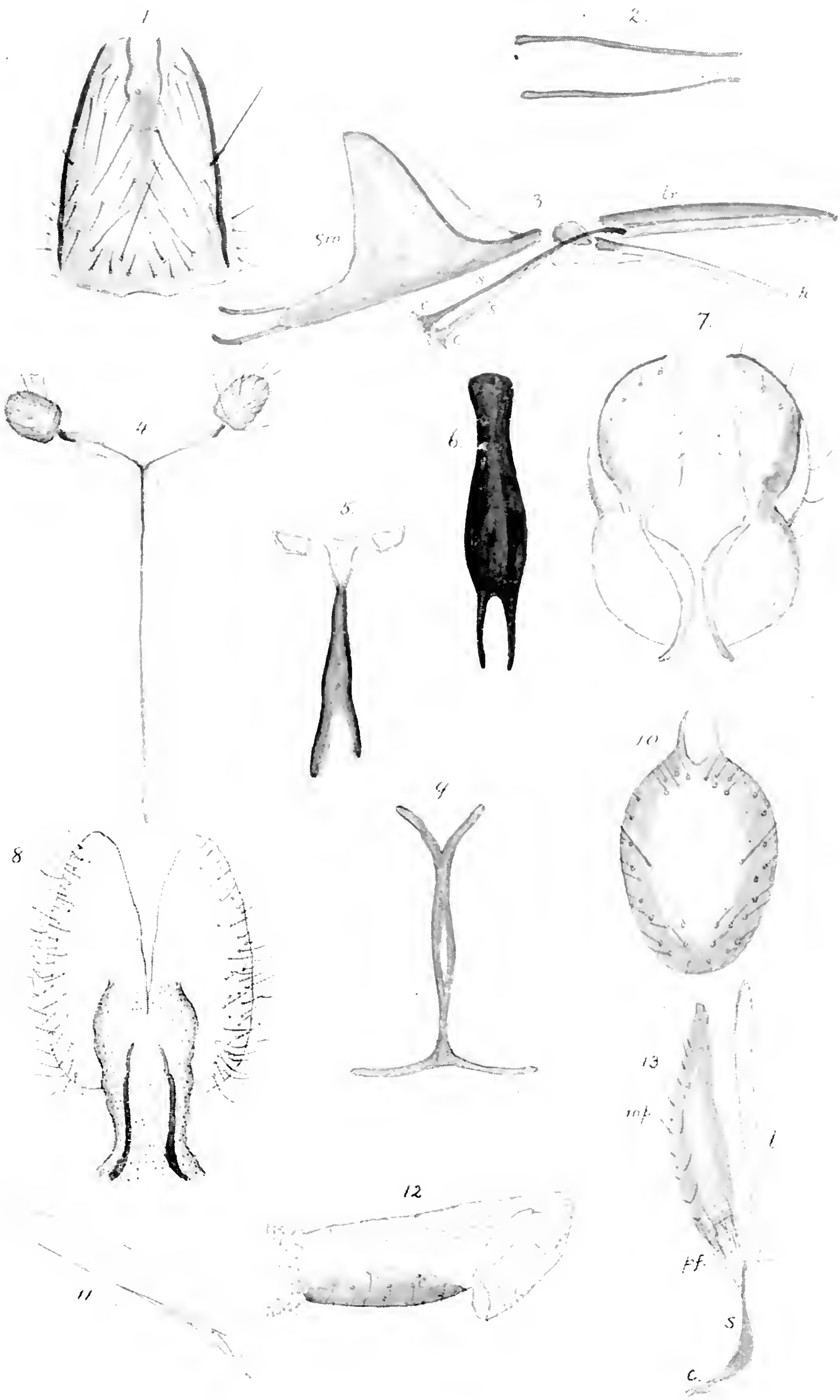
them an account of how he became Librarian. He became a member of the Club in the first year of its existence (1866), and soon found himself at home. The meetings were then held in the library of University College on the fourth Friday. After three or four years a wish was expressed by members that there should be some meetings less formal than the ordinary meetings, where members could bring up microscopes, and have opportunity to discuss matters with each other. The existing committee favoured the idea, and such meetings were arranged to be held during the winter, and proved very successful. It was determined to continue, and from these their regular "Gossip" evenings had come, which had been so successfully conducted, and had been of such great value to the Club. As the meetings became more popular, the then librarian asked for assistance, and he (Mr. Smith) was asked to help, having previously assisted in a number of small ways. At first he helped Mr. Jaques on "Gossip" nights, but subsequently, at the request of the committee, took full charge. This was just thirty-six years ago. He had been a member for forty-two years. In concluding, and after thanking the members for their gift, Mr. Smith said he had worked with five secretaries, and that he had always received the greatest possible amount of assistance from all concerned.

A paper on "The Proboscis of the Blowfly, *Calliphora erythrocephala*, Mg.: a Study in Evolution," communicated by Mr. W. Wesché, F.R.M.S., illustrated by several preparations under microscopes, and by blackboard diagrams, was read by the Hon. Secretary.



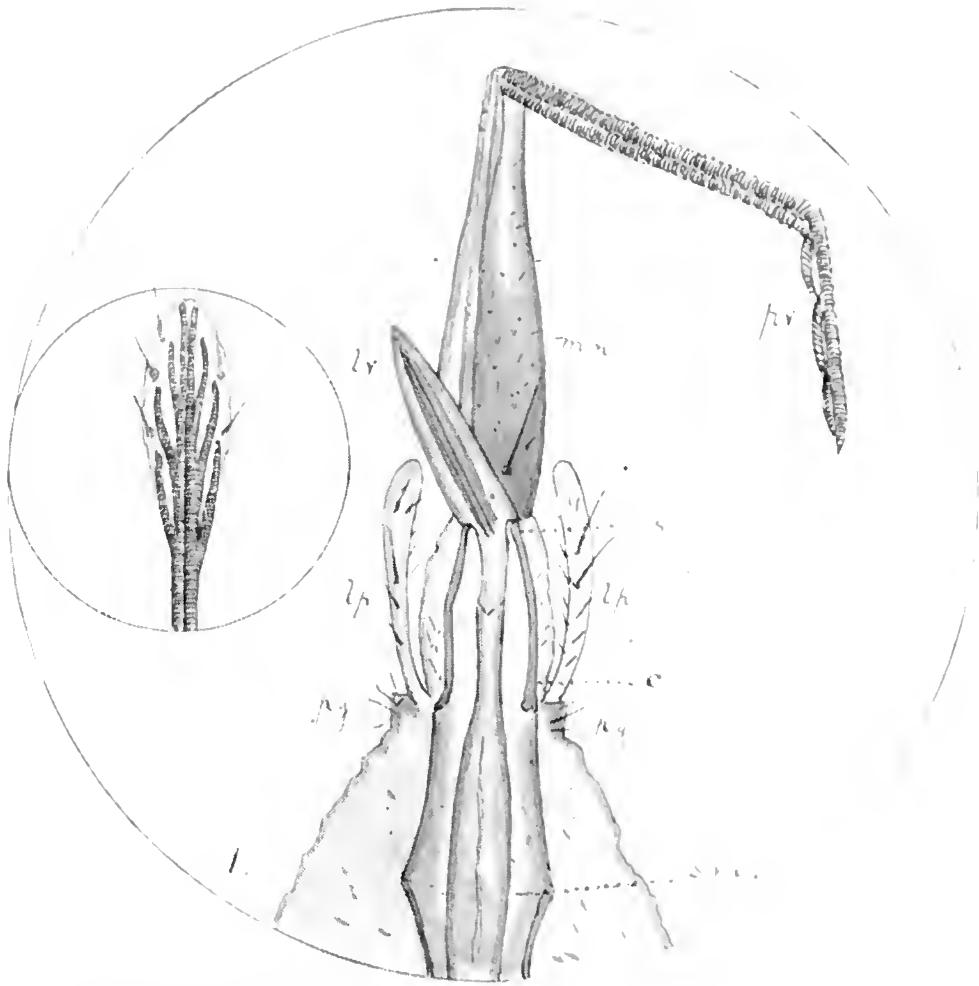
C. D. Soar, *ad nat. del.*

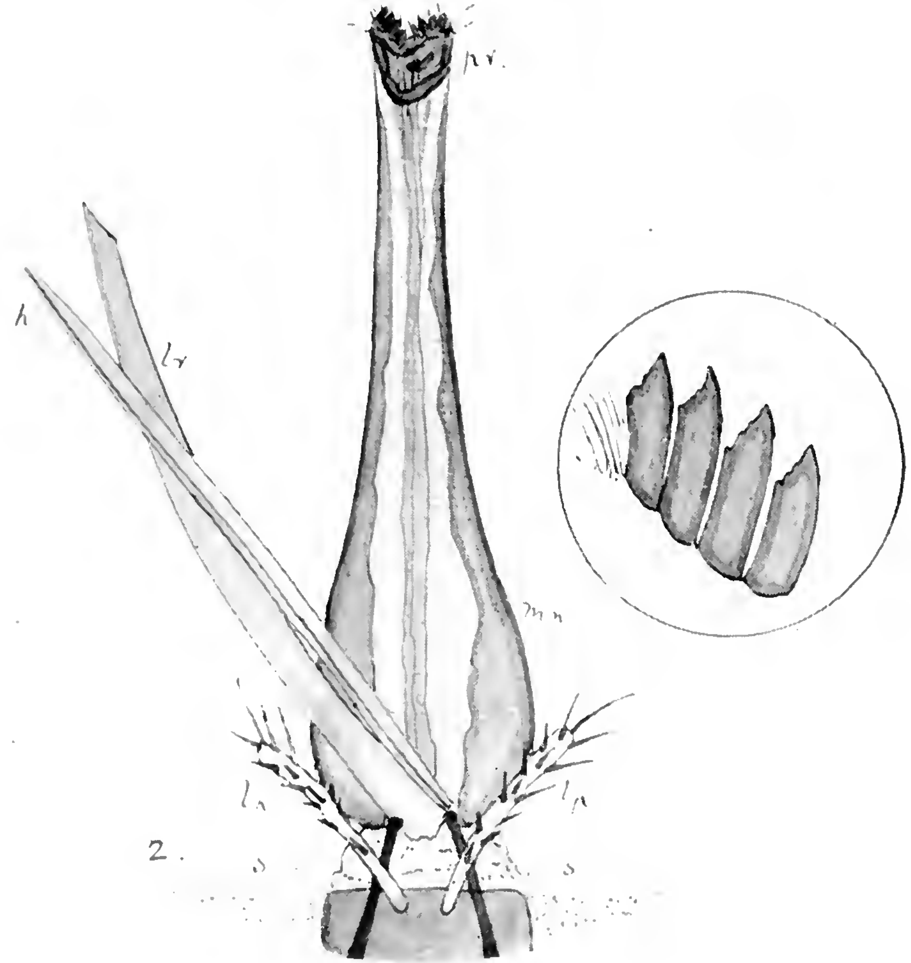
British Hydrachnae.



W. Wesché, *ad nat. del.*

Mouth-parts of Diptera.

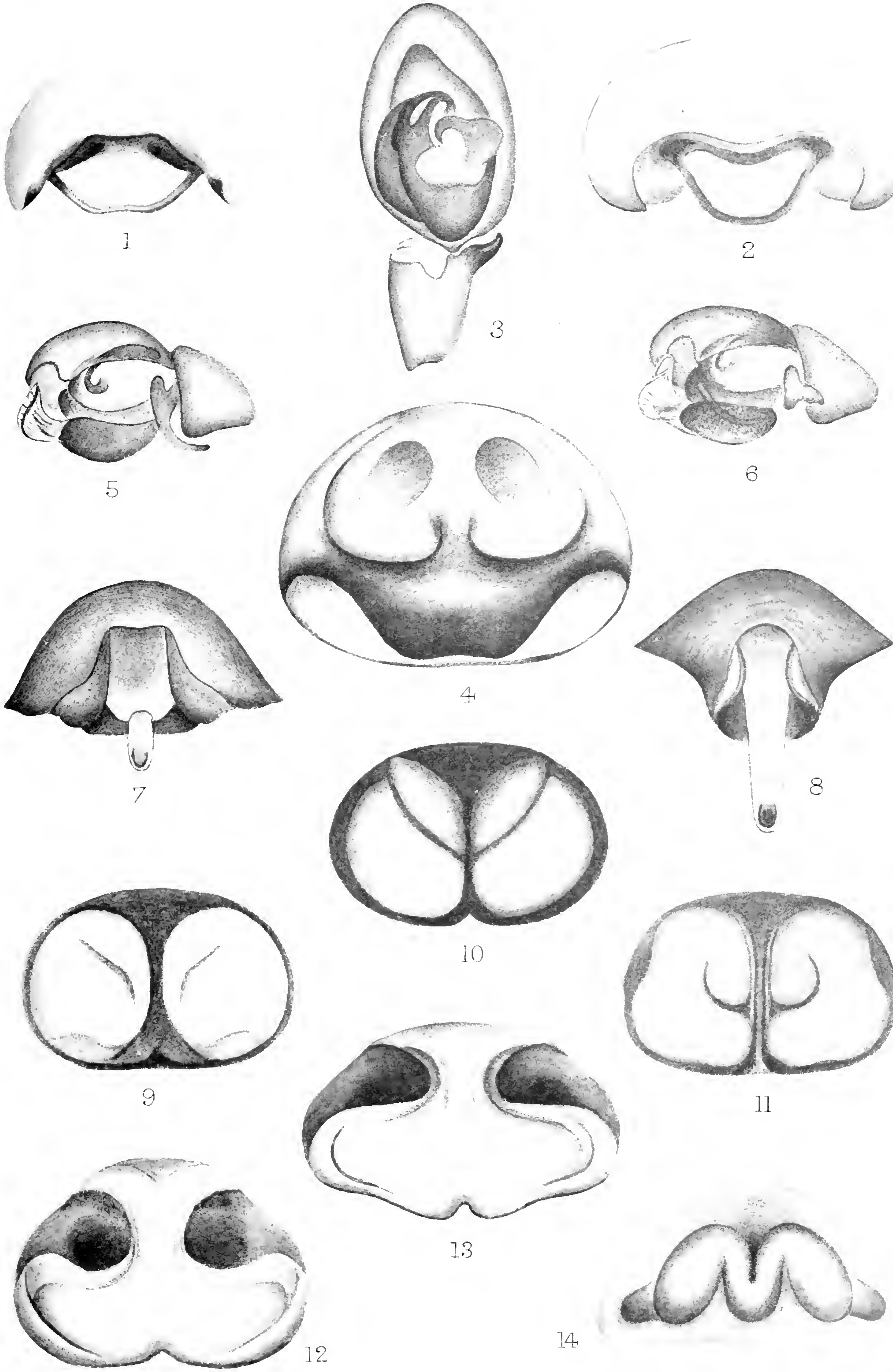




W. WESCHÉ, *ad nat. del.*

MOUTH-PARTS OF DIPTERA.

Hymenolepis fraterna...



Frank P. Smith, ad. nat. del.

BRITISH ARANEIDEA.

1. 2. 3.

Notholca bostoniensis.

Notholca bostoniensis and longispina
Pterodina parva.

A SIMPLE DRAWING AND PROJECTION APPARATUS FOR MICROSCOPICAL LOW-POWER OBJECTS.

By Walter Imboden, F.R.M.S.

(*Read February 21st*, 1908.)

Feeling sure that many a microscopist has longed for a simple appliance by means of which he would be enabled accurately to trace microscopical images without the possession of special drawing facilities, and without the strain upon the eye and neck experienced in the employment of the majority of forms of camera lucida, I am bringing this simply constructed but highly efficient piece of apparatus before your notice.

I had for a considerable time been in want of some satisfactory contrivance, until the idea struck me to project the microscopical image directly upon the drawing surface, where it could be traced in the most convenient and easy manner; and it is the object of this paper to give the necessary information upon the subject.

The sum-total of the necessary apparatus is as follows:

(1) A microscope inclined to a horizontal position, fitted with a long-focus condenser, a one-inch objective, and one or two oculars;

(2) A projecting mirror;

(3) A light-screen; and

(4) An adequate illuminant.

Of these the projecting mirror and the light-screen call for some description.

A piece of ordinary good-quality mirror, about 4 × 3 inches in size, is fixed to a metal arm about $4\frac{1}{2}$ inches in length. This arm is connected with the draw-tube of the microscope by means of a clamping ring. A glance at Fig. 1 will make the arrangement clear. The mirror is fixed to the supporting arm in such a position as to face the front of the ocular at an angle of 45°. It can, of course, be brought nearer to or farther from the ocular by sliding the arm in or out, thus providing a ready method of securing a certain range of magnifications without changing the objective or the ocular.

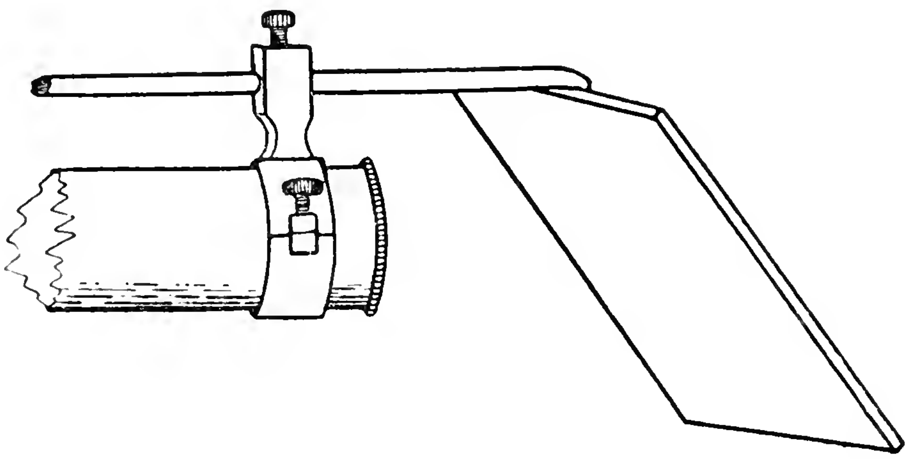


Fig. 1.

A drawing surface lying horizontally upon the table receives the projected image.

It is next necessary to protect the image from any extraneous light which would tend to impair its brilliancy, and with that end in view we have to consider some kind of light-excluding appliance. A camera obscura would certainly be the most effective arrangement if the brilliancy of the projected image were the sole consideration; but as we find in practice that an almost even illumination of the whole drawing surface with a small balance in favour of the image itself constitutes the most favourable condition to execute and follow the progress of the sketch in hand, we do not require more than a small screen to control

superfluous light. When working, however, in a brightly illuminated room in daylight, a more effective screen will be found necessary. We therefore have recourse to a box-like shade, easily constructed of cardboard or thin wood, and illustrated in Fig. 2, which shows the draw-tube of the microscope with the mirror attached projecting through the opening at the back, and the sketch-board in position.

With regard to the illuminant, the light from a good paraffin lamp will be found sufficient for a considerable amount of work

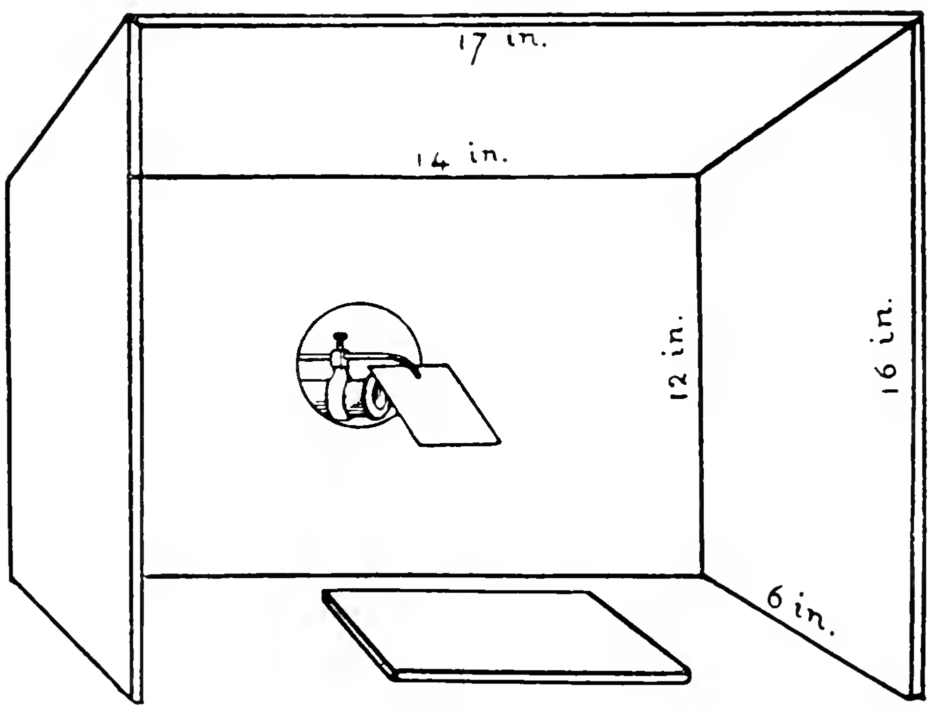


Fig. 2.

with low-power objectives. The advantage of a more brilliant light, however, cannot be denied; in fact, it is a necessity when high-power work is contemplated. At the same time the successful manipulation depends more upon the adjustment of the illuminant than upon the actual amount of light available.

Before concluding this paper I wish it to be understood that I am not bringing this piece of apparatus forward as a new invention. It is, in fact, merely a practical application of the reflecting property of the mirror.

Many years ago Mr. Nelson recommended an almost identical appliance, which for some reason or other seems never to have been generally adopted. I should feel amply rewarded if my little contribution awakens a new interest in Mr. Nelson's drawing mirror, as it is, without doubt, a most practical and useful little instrument.

THE LOCOMOTION OF MICROSCOPIC AQUATIC ORGANISMS.

By D. J. Scourfield, F.Z.S., F.R.M.S.

(*A Resumé of a Lecture delivered on December 4th*, 1908.)

Before considering the various special methods of locomotion exhibited by microscopic aquatic organisms, a brief reference to some of the general conditions of locomotion under water, and the problems arising therefrom, will, I hope, make the subject somewhat more interesting and at the same time serve to show that the study of such matters is of wider significance than might at first sight be supposed.

At the outset it must be remembered, in regard to organisms living in water, that the medium in which they are immersed affords them very considerable support, not only for their bodies as a whole, but for all their appendages and outgrowths if such be present. This of course is due to the fact that the majority of organisms are, in the main, made up of tissues having a specific gravity differing very little from that of water, and the result is that extremely delicate and jelly-like creatures can live without difficulty in water. The most delicate and fragile of all known organisms are, as a matter of fact, found in water.

In consequence of this equable support and the comparatively small amount of friction to be overcome, very little energy has to be expended to produce slow movements, and if the organisms are actually of the same specific gravity as water and can get their nourishment directly from the substances dissolved therein, as sometimes happens, it is not necessary for them to be provided with swimming organs at all. They can then depend entirely for change of position upon the never-ceasing movements, due to various physical causes, taking place within the water itself.

As water, when compared with dry land, offers such a small amount of resistance, it is at once apparent that for movement

at any but the slowest speeds the locomotive organs must either possess very large surfaces so as to get a grip of the water, or, if small, they must act in a very rapid manner. Numerous instances of both of these arrangements occur among microscopic aquatic creatures.

On the other hand, as compared with air, the resistance offered by water is very considerable, and although this implies that the locomotive organs of aquatic organisms need not be so large nor act as rapidly as those of flying creatures, it does mean that for quick locomotion the organism should be fashioned so as to offer the least amount of obstruction to its passage through the water. It thus comes about that most of the good swimmers are of an elongated form and especially of some modification of the fusiform type.

There is one other consideration in connection with locomotion under water which may be referred to, for it is one which has made itself very much felt in connection with the navigation of submarine vessels. It is the difficulty of keeping a straight course owing to the want of fixed points or datum lines, for both horizontal and vertical directions, from which bearings may be taken. Some automatic arrangement is necessary, and various contrivances for this purpose are to be found among aquatic creatures, but the most common, at least among the lower forms, is the power of rotation on the long axis. This rotation produces a compensating effect for any little irregularities in shape or motive power, so that, although the actual path really becomes a long spiral, its general direction is practically a straight line.

Coming now to some of the different kinds of locomotion found among the minute inhabitants of water, we must commence by glancing at the so-called amoeboid motion. This, as the name suggests, is typically seen in the *Amoeba*, a very lowly form of animal life, often described, though not quite accurately, as a mere "speck of animated jelly." The locomotion is produced in the simplest conceivable way, namely, by the flowing out in various directions of portions of the actual body-substance of the animal. One of these outflowing processes, or pseudopodia as they are called, usually becomes bigger than the others, and finally draws the rest of the body into itself, so that the whole comes to occupy a new position; and as the formation of new

pseudopodia goes on without cessation, there is a continuous movement of the whole animal, though not usually in any definite direction. Examples of amoeboid movements of various kinds are very common among the class to which the *Amoeba* belongs, namely, the Rhizopoda, including the well-known Foraminifera. Owing to the observations and ingenious experiments of Bütschli, Rhumbler, and others, it now seems very probable that in its main features amoeboid motion is essentially a physical phenomenon depending chiefly upon changes in the surface-tension of the naked protoplasm of these organisms.

The points to be remembered in relation to amoeboid motion are that it is brought about by an actual flowing out of the semi-liquid protoplasm, that the pseudopodia so produced are only temporary organs of locomotion, and that their movements are too slow to be effective except when they are in contact with solid bodies. But in connection with the latter remark it is to be noted that there are a few forms (*e.g.* one of the varieties of *Amoeba radiosa*) in which the pseudopodia are long and pretty vigorous in their movements, sometimes swaying about so rapidly that they can be imagined to form a transition from typical pseudopodia to the flagella or whip-like organs which we have next to consider. In other intermediate forms there exists a combination of pseudopodia and flagellum in the same individual (*e.g. Mastigamoeba*).

The second type of locomotion to which we will devote attention is that due to the action of flagella. There are certain difficulties in framing an exact definition of a flagellum, but I look upon it as a permanent, motile, whip-like extension of the living protoplasm, capable of moving the whole organism to which it belongs, and capable of independent motion if, as is sometimes the case, it is accompanied by other flagella. I believe also that the mechanical action of a flagellum in producing locomotion, a subject to be dealt with presently, is quite characteristic.

The source of movement of a flagellum appears to reside in the flagellum itself. A close connection has, however, been made out in many cases between the flagellum and the nucleus of the cell; and it is probable that even though the motive power of the flagellum cannot be referred to the nucleus, the latter exercises some control over the former. Flagella usually originate from

one extremity of the body only, the most constant arrangement being a single flagellum attached to the anterior end and directed straight forward in locomotion. But they may occur at both ends (*e.g.* some *Bacteria*), or in the middle (*Dinoflagellata*), or in various other ways.

The question now arises, How can a single, simple whip-like outgrowth produce a movement of the whole organism to which it is attached? It is evident that mere lashing or vibrating cannot effect this. Even if such lashing were imagined to be stronger in one direction than another, it would still be impossible to account for the steady progress in the line of the long axis of the body which actually occurs. No; the only way in which such locomotion can be brought about under the conditions named seems to be by a succession of waves travelling backwards along the flagellum, and there is good reason for believing that this really takes place. The waves, however, are probably never confined to one plane, but rotate as they progress, thus throwing the flagellum into a spiral form. The effect, in fact, is exactly the same as would be produced by a rotating corkscrew, but there is this essential difference, that the flagellum does not rotate, and the mechanical problem which is thus involved is one by no means easy to solve. For my own part I can see no way of making a piece of apparatus which could do the work of a flagellum, and do it in the same way, although it is very easy to imitate the action by means of a piece of cord, one end of which hangs freely in the air, while to the other a circular motion is imparted by the hand.

An important by-product, so to speak, of the spiral action of a flagellum is the rotation of the whole body of the organism on its long axis. This can be easily shown to result from the oblique backward thrust of the spirals of the flagellum, which, by the application of the parallelogram of forces, can be resolved into two factors, one pulling the organism forward, the other acting circularly at right angles to this, *i.e.* tending to rotate the whole body in the opposite sense to the spiral movement of the flagellum. The usefulness of this rotation, from the point of view of the organism keeping a straight course when swimming, has already been referred to.

Flagella, unlike cilia, are practically confined to the lowest forms of animal and vegetable life, and are by no means of

general occurrence even among these. The best-known group in which they are found is the Flagellata or Mastigophora, a subdivision of the Infusoria. They also occur in many different kinds of Algae and Bacteria.

Leaving the subject of locomotion due to flagella, it is an easy passage to that caused by the action of cilia. Here, again, a definition is not altogether free from difficulty; but my own conception of a cilium is that it is, like a flagellum, a permanent, motile, whip-like extension of the living cell-substance, but that, unlike a flagellum, it is incapable of moving the body to which it is attached by its own individual efforts (being usually small in comparison with the body), while it is always associated with a number of other cilia with which it acts in harmony. Probably the mode of its action is also characteristic.

A large amount of attention has been given to the structure of cilia, and it has been maintained that they consist of a number of separate parts, namely, root (sometimes connected with the nucleus), immotile rod, basal granule, bulb, and terminal vibrating piece. This complicated structure, however, is certainly not always present. In fact, there are excellent reasons for thinking that the only essential part of a cilium is the vibrating thread. Of course, the connection with the nucleus, when it occurs, seems to show that the control of the cilium may be from within the cell, but the motive power is pretty certainly contained within the cilium itself. Cilia may occur almost uniformly covering the whole body of an organism (many Infusoria, Planarians, etc.), or they may be limited to special areas or arranged in bands, wreaths, and other ways (Infusoria, Rotifers, Gastrotricha, etc.).

Various theories have been put forward to account for the locomotion produced by cilia. The simplest of these, and the one generally accepted, is that the cilia act with a simple lashing movement in one plane, but with the motion in one direction much quicker, and therefore stronger, than in the other. Such action has been directly observed in some cases, and the supposition that it is the normal movement of cilia fits in very well with the observed facts of the locomotion of ciliated organisms. Usually the successive rows of cilia exhibit a slight retardation in the moment of lashing, so that an appearance is produced as of waves travelling over a field of corn. Sometimes the illusion produced by these waves is so marked that it seems to be an

actual change of position that is taking place among the cilia. The well-known ciliary organs of many Rotifers, looking just like rotating cog-wheels, is a case in point.

Many ciliated organisms rotate as they swim through the water, and it is possible that this may be brought about by the cilia beating somewhat obliquely to the direction of the long axis of the body. In numerous cases, however, it would not be necessary to make this assumption, as the shape of the body is such (more or less spiral as a whole, or provided with twisted ridges, grooves, etc.) that it would naturally rotate when propelled through the water. The result in either case is the same, and it is of obvious advantage to the organisms, as already pointed out.

The presence of cilia for locomotive purposes is found to extend to many very different groups of creatures. The ciliated Infusorians, of course, exhibit these organs in perfection, but they also occur (either constantly or in certain stages of development) in such diverse forms as Sponges, Hydrozoa, Echinoderms, Worms, Rotifers, Gastrotricha, and Mollusca. I am inclined also to include such a form as *Volvox* as a ciliated organism, in spite of the fact that there are only two motile threads attached to each cell in the colony, and that they are commonly alluded to as flagella; for the general result of the action of all the threads seems to me to be of the ciliate and not of the flagellate type, and it is extremely doubtful whether the individual threads act in the spiral manner described in connection with flagella.

Before going on to the consideration of locomotion produced by specialised appendages, a few words may be said about two or three kinds of progression which depend upon various movements of the whole body. For instance, there is what may be called the medusoid motion, which consists of the sudden closing of a more or less umbrella-shaped organism. This type of movement is shown among microscopic forms by the curious Protozoan *Leptodiscus* and also by the tiny medusoids of some Hydrozoa. Then there are a large number of small aquatic creatures which progress by throwing their bodies into a series of waves or even figures-of-eight. The Nematodes are excellent examples of this, but many other worms, and also insect larvae, propel themselves through the water in this way. Yet another

type is seen in *Salpa*, where we get a pumping or squirting method of locomotion, water being taken into the body and then forcibly ejected.

We now reach the most highly developed form of locomotion, namely, that due to definite appendages worked by special muscles. Among the Rotifers there are certain species which possess what have been called skipping organs, consisting of a few spines, by the sudden movement of which the animals can dart about in a very rapid way. Such forms are *Triarthra* and *Polyarthra,* and their erectile spines may be regarded as locomotor appendages in their simplest form. There is, however, a still more important example of rudimentary swimming appendages to be found in another genus of the same group, viz. *Pedalion*, where the spines are placed on distinct bumps and outgrowths provided with special muscles, thus forming something very closely resembling true limbs. Such a form as this serves, in this respect at least, to bridge over the gap between the worms and Arthropods.

Among the simplest cases of animals possessing true appendages, such as legs, adapted for swimming, we may instance the Water-mites (Hydrachnidae). In these the only modification that has taken place is that certain special tufts of hairs have been developed on the legs in the forms capable of swimming which do not occur in the crawling forms. Numerous aquatic insects also show modifications of the legs, and very exceptionally of the wings, for locomotion under water, but most of these animals can scarcely be called microscopic. It is rather among the little Crustaceans known as Entomostraca (some of which are often referred to as Water-fleas) that we must look for the highest development of swimming appendages among microscopic aquatic organisms.

The most primitive of these, the Phyllopods, possess very many pairs of foliaceous feet of elaborate and beautiful construction, which beat the water with a kind of rhythmic swinging, the resulting movement of the animals (at least, in the species not wholly enclosed in shells) being exceedingly graceful. In the closely related Order of the Cladocera, the swimming movements are brought about not by the feet, which have been reduced to five or six pairs and only possess functions accessory to feeding and respiration, but by a special adaptation of the second pair

of antennae. In many cases these organs are very powerful, so that, aided by an elongated and compressed form of body, the progression of these little animals may be very rapid. The direction of the stroke of the antennae, at least in the genera *Daphnia* and *Simocephalus*, has been found to be slightly oblique to the axis of the body, having a slight inclination towards the back—a circumstance which gives rise to a tendency for the locomotion to take place in a curved path. This, however, is counteracted partly by the action of gravity on the body between the strokes, and also probably by the resistance offered to the turning movement by the long shell-spines which most of the more rapid swimmers possess.

But it is among the Copepods or "oar-footed" Entomostraca that the most elaborate natatory appliances exist. The four or five pairs of feet are usually broad, two-branched, paddle-like organs provided with fringing hairs and feathered spines. They can be jerked backwards with extreme rapidity, at the same time spreading out laterally in various degrees so as to present a greater surface to the water. The first pair of antennae can also be suddenly reflexed, and may no doubt help in locomotion in some cases, although probably not usually concerned in this matter. The tail, however, with its feathered setae pretty certainly assists in locomotion, but its exact action requires further investigation. In addition to these three sets of locomotor appendages, the members of one family, Calanidae, have yet a fourth means of progression, namely, by the very rapid vibration of their second antennae and maxillae, by means of which a graceful gliding motion is produced.

There are several kinds of locomotion exhibited by minute organisms found in water which have not been alluded to in the foregoing remarks, either because they are at present quite unexplained or very imperfectly understood. As examples may be cited the movements of Diatoms, Desmids, and Oscillatoria. Many attempts have, indeed, been made to explain some of these movements, especially by Lauterborn in connection with Diatoms, but the matter is still involved in much uncertainty.

In conclusion, it may be pointed out that the whole subject of locomotion among microscopic aquatic forms of life is one which still offers a fruitful field for study. Not only are additional

observations of the ordinary kind required on large numbers of species of all classes, but entirely new methods of investigation will have to be devised, and very considerable improvements of old methods, such as instantaneous photography, etc., carried out, before we can hope to solve the many interesting problems presented to us in connection with the movements of living organisms in water. In fact, there is work here for many scientific labourers, professional and amateur alike, whether having command of the highest powers of the microscope or limited to the lowest, whether mainly interested in experimental investigations or content to take Nature's gratuitous statements without further questioning.

The following list of literature, although very imperfect, will probably be found helpful by those who may wish to go into this subject more deeply than it has been possible to do in the present paper.

BETHE, A. "Ueber die Erhaltung des Gleichgewichts," *Biologisches Centralblatt*, Bd. 14, 1894, pp. 95–114, and 563–82.
(Gives results of many experiments as to specific gravity of aquatic animals, their means of orientation, maintenance of equilibrium, etc.)

BÜTSCHLI, O. "Protozoa" in Bronn's *Klassen und Ordnungen des Thier-Reichs*, 1880–9.
Abt. I. Sarkodina and Sporozoa, pp. 114 *et seq.*, 284, 442 (amoeboid motion).
Abt. II. Mastigophora, pp. 846 *et seq.*, 956, 1085, (flagellate motion).
Abt. III. Infusoria, pp. 1788 *et seq.* (ciliate motion).

BÜTSCHLI, O. *Untersuchungen über mikroskopische Schäume und das Protoplasma*, 1892. English translation, *Investigations on Microscopic Foams and on Protoplasm*, 1894. (Records the results of experiments with "artificial Amoebae.")

CALKINS, G. N. *The Protozoa*, 1901. (Contains remarks on the structure and action of pseudopodia, pp. 79–86; flagella, pp. 119–23; and cilia, p. 181.)

JENNINGS, H. S. "Asymmetry in Certain Lower Organisms and its Biological Significance," *Mark Anniversary Volume*, 1903, Art. xvi. pp. 315–37. (An interesting paper dealing with spiral structure and spiral locomotion.)

JENNINGS, H. S. "A Monograph of the Rattulidae," *U. S. Fish Commission Bulletin* for 1902, 1903, pp. 273–352. (Contains, pp. 293–8, an account of the spiral method of progression among certain Rotifers.)

LAUTERBORN, R. *Untersuchungen über Bau, Kernteilung und Bewegung der Diatomeen*, Leipzig, 1896. (A summary of the section dealing with the movements of Diatoms by F. R. Rowley appeared in *Natural Science*, December, 1898, pp. 406–16.)

PARKER, G. H. "The Reactions of Copepods to Various Stimuli," *U. S. Fish Commission Bulletin* for 1901, 1902, pp. 103–23. (Records many observations on the movements of certain Copepods, pp. 105–8.)

RHUMBLER, L. *Zellenmechanik und Zellenleben*, Leipzig, 1904. (A useful summary of the present state of knowledge with regard to the "mechanics" of cell movement, etc.; also contains references to numerous special papers on the same subject.)

SCOURFIELD, D. J. "The Swimming Peculiarities of *Daphnia* and its Allies, with an Account of a New Method of Examining Living Entomostraca and Similar Organisms," *Journal Quekett Microscopical Club*, Ser. 2, Vol. VII., 1900, pp. 395–404. (Mainly treats of the position assumed in swimming by species of *Daphnia* and *Simocephalus*.)

VIGNON, P. "Recherches de Cytologie Générale sur les Epithéliums," *Archives de Zoologie Expérimentale et Générale*, Ser. 3, Tom. IX., 1901, pp. 371–720. (Contains a large amount of information about cilia.)

ZELINKA, C. "Studien über Räderthiere, II. Ueber die Symbiose und Anatomie von Rotatorien aus dem Genus Callidina," *Arbeiten aus dem Zoologischen Institut zu Graz*, 1886. (Contains the best account of the movement of cilia in Rotifers.)

(The above resumé has been previously printed in the "Journal of the City of London College Science Society," Vol. X., No. 7, April 1905.)

THE STRUCTURE OF THE EYE-SURFACE, AND THE SEXUAL DIFFERENCES OF THE EYES IN DIPTERA.

By W. Wesché, F.R.M.S.

Plate 28.

(*Read March 5th*, 1909.)

The fact that the eyes of the male insect are larger, in the majority of cases, than those of the female is well known, and this difference is generally accepted as a secondary sexual character. We are probably correct in assuming that a greater amount of eye-surface gives room for a greater number of facets, and a greater number of facets gives increased power of vision, and consequently enables the insect more readily to find his mate. We see this character carried to its extreme development in many flies, as in the Pipunculidae, where the head of the male is almost entirely occupied by the compound eyes, and the female has acquired only a lesser measure of the same development. The Cyrtidae have gone a step farther, as in one species, *Oncodes gibbosus*, L., the female has arrived at an equally extreme state of development with the male.

Williston * mentions that there are cases in which the female has gained the character in advance of the male, giving a reference to the Cyrtidae and an instance in the Bombylidae.

Regarded as a sexual character, Osten-Sacken has called the contiguity of the eyes of the male and the separation of the eyes of the female "holoptic." As opposed to this, there are multitudes of species and genera where no such difference exists, the eyes being widely and equally separated in both sexes, as in many of the Mycetophilidae, Chironomyidae, Tipulidae, and

* "Antennae of Diptera; A Study in Philogeny," *Bio. Bull.*, vol. xiii. No. 6, p. 331, November 6, 1907: New York.

Muscidae. The Caenosia group of the Anthomyidae, and the family Cordyluridae of the Acalyptrates, may be cited as examples in the Muscidae; for such cases Williston has suggested the convenient term "dichoptic," as the antithesis of holoptic.

But these are not the only differences. Besides size there are cases in which the eye is divided by an obvious structure into an upper and a lower part, as in some of the Bibionidae (Fig. 2, Pl. 28). Again, there may be a difference in the size of the facets, those on the upper part and the front of the head being considerably larger than those on the lower part. This character seems in some measure an approximation to the last mentioned. It is found in a surprising number of families, including the Simulidae in the Nemocera, the Stratiomyidae in the Brachycera, and the Syrphidae in the Cyclorrapha.

In the curious Muscid family of the Diopsidae, the eyes are placed on long stalks which project from the head. Finally, the eyes may be more or less pubescent, which condition, although often common to both sexes, is in many instances a sexual character, as in *Bibio*, where the male has remarkably long hairs on the eyes (Fig. 13), while those of the female are bare, or only have a few scattered exceedingly minute hairs.

A microscopic examination of the eyes, in preparations properly cleared, reveals a great difference in the structure, a difference by means of which we can divide all the species of Diptera into two groups. In the first, a markedly chitinous plate is pierced by the facets, or lenses; this is found in varying degrees of degeneration through an immense series of forms, the partial absence of the opaque structure increasing the light-absorbing capabilities. In the second group the chitinous plate and all opaque structures have disappeared.

Before proceeding to more minute descriptions, I shall recapitulate these points.

General characters.

All eyes in Diptera either (*a*) have a chitinous structure enclosing the lenses, or (*b*) are without such a structure.

Sexual characters.

1. The larger size of the eyes of the male and the wider separation of the eyes of the female (the "holoptic"), or the equal separation of the eyes in both sexes (the "dichoptic").
2. The division of the male eye into an upper and lower eye.
3. The variation in size of the facets of the eyes of the male.
4. The situation of the eyes on lateral projections.
5. The pubescence of the eyes.

On the Presence or Absence of Chitinous Structures round the Lenses of the Eyes.

Notes and Observations on which the Conclusions are Founded.

My preparations of the Cecidomyidae and the Mycetophilidae exhibit in the majority of cases circular lenses with a markedly chitinous structure surrounding them (Figs. 1, 3, 4).

In *Bibio marci*, L., the chitin has almost disappeared, but there remains a fine line dividing the facets into fairly well marked hexagons. This is much less clearly defined in the female of *B. hortulanus*, L., though the male shows it clearly (Fig. 13).

In *Dilophus febrilis*, L., the hexagons become almost circular, and the chitin is a trifle more evident than in *B. marci* (Fig. 5).

A New Zealand insect, *D. nigrostigma*, Hutton, shows a more chitinous structure (Fig. 12).

A single specimen of *Plecia fulvicollis*, Wied., from Ceylon, shows a structure close to that of *B. marci*. The small *Scatopse* (two species *S. notata*, L., ♂ ♀, and *S. minutissima*, Verral, ? ♂) show a similar structure to that found in the Mycetophilidae.

In *Ceratopogon* the lenses are circular, but the chitin is less than in *Scatopse*, more like *Cecidomyia*. In *Chironomus dorsalis*, Mg., and *C. plumosus*, L., the round lenses in the curiously bent plate are always evident.

In the four families, Chironomyidae, Psychodidae, Culicidae and Mycetophilidae, the plates bend round the upper part of the head, leaving a space for the insertion of the antennae, and

adjacent to them are small areas of chitin, which are not pierced by the customary round lenses (Fig. 11).

This is well seen in *Ulomyia fuliginosa*, Mg., to give one instance out of many; one preparation of an undetermined *Psychoda* shows a weaker chitinous structure, with larger facets than those on thirteen other heads belonging to three species which I examined.

In *Corethra plumicornis*, F., the chitinous structure, though much less than in *Chironomus*, is still very marked; certainly more so than in *Mochlonyx velutinus*, Ruthé, or *Culex*, where it only defines the lenses, which appear to be showing signs of becoming hexagonal. In many species the compound eyes are of the same shape as the plate in *Chironomus*.

Of the Ptychopteridae five species were examined (*contaminata*, L., *paludosa*, Mg., *lacustris*, Mg., *albimana*, F., *scutellaris*, Mg.). All have the chitinous structure highly developed, but the lenses incline to the hexagonal form. An even stronger structure is found in *Gynoplistia bella*, West., and it is very similar in *Tipula oleracea*, L., the sides of the bands separating the facets appearing to be deeper, a point to which I shall again allude when I come to inquire into the uses of these various modifications.

In *Rhyphus fenestralis*, Scop., and *R. punctatus*, F., the chitinous structure is very weak, but can be traced, short hairs being inserted at the apex of each angle.

In those cases in which the lenses are hexagonal with strong chitinous structure, the hexagonal description only refers to the majority of the facets; in many instances they are modified into very irregular shapes to conform to the curvature of the eye-mass.

This brings us to the end of the Nemocera, and shows us that, although we constantly find variations, especially in the larger families, this chitinous structure of the eye is a very primitive character, persisting through the whole of the sub-order; it appears to have been lost in the genera *Bibio* and *Culex*, yet it is evident in the more primitive *Scatopse* and *Corethra*. The circular facet or lens is also a very archaic character.

In the Brachycera we again find the chitinous structure more or less developed in the different families. It is very strong in the Asilidae, passes through a complete gradation in the Empidae, being very strong in *Clinocera stagnalis*, Hal., less in *Pachymeria femorata*, F., and absent in *Hybos*. In this latter it is in a similar condition to that found in the specialised Muscidae. In the Dolichopodidae it is never so strong (in the examples in my cabinet drawn from fourteen genera) as in *Clinocera*, but it is generally easily recognisable.

In the eyes of a number of species of Phoridae the lenses are bordered by chitinous bands, and a similar condition can be seen in *Lonchoptera flavicauda*, Mg.

In the Leptidae it is markedly chitinous in the genus *Leptis*, and weaker in *Chrysopilus*.

All the preparations of Stratiomyidae I possess have strongly marked chitinous structure. Examples from eight of the principal genera have been examined.

It is very marked in all the Tabanidae I have examined, with the exception of *Chrysops*. But in the male of *Haematopota pluvialis*, L., I have met with a most striking variation. The lenses differ in size, the lower being much smaller than the upper; and these smaller lenses are strongly defined with chitinous structure. The larger lenses lack this chitin, but between the two sizes we find a small space—a transition area, as it were—which shows the chitin in a degenerating condition (Fig. 8).

As I have in a former paper in this Journal * suggested (on the evidence of the mouth structure) that this genus is probably close to an ancestral form of the Muscidae; and as the Muscidae are without these chitinous structures, we can assume that this eye possibly shows the transition stage. The exotic *Pangonia longirostris* shows a similar structure to *Tabanus*.

Bombylius discolor, Mik., ♂, shows the chitinous structure well developed, as also does the Cyrtid *Oncodes gibbosus*, L.

* "The Proboscis of the Blow-fly," *Journ. Quekett Microscopical Club*, Ser. 2, Vol. 10, No. 63, p. 283.

In the Cyclorrapha we find the large family of the Syrphidae with the lenses still well defined, and separated by chitinous bands; but this is markedly less in the Conopodae, and in the Muscidae the opaque structure has completely disappeared, so that in prepared specimens it is, in the majority of cases, difficult to see the lenses clearly.

Summary.

A number of observations have been recorded (made on about forty-two families and a number of genera) with regard to the eye-structure. From these it is assumed that the highly chitinised plate, pierced with circular apertures for the lenses, is the most primitive form, which is quite in agreement with observations on insects of very ancient type in other orders—insects which possess only simple eyes—that as we ascend in the scale of the flies, the facets begin to be hexagonal and there is much less opaque chitin, until finally, in specialised insects like the Blow-fly (Calliphora), the opaque structure has quite disappeared, permitting all the rays of light to enter the eye. One very remarkable eye shows these stages in transition; this is the eye of a male, the female retaining the more archaic type Most of the large families include species which have attained conditions similar to those which we find in the Muscidae, the family Empidae furnishing examples, in three different genera, of the transitional stages.

The Sexual Characters.

1. *The Holoptic and Dichoptic Eyes.*

Little need be said on this subject except that the holoptic eye is rare in the Nemocera, my only examples being in a *Cecidomyid*, *Bibio*, *Dilophus*, and *Simulium ornatum*, Mg.

In the Brachycera the holoptic eye is more often met with than the dichoptic, and in the Pipunculidae and the Cyrtidae the character has even gone beyond that condition, as the whole head in both sexes is occupied by the eyes, a slightly wider separation

being found in the female Pipunculidae. The Phoridae, Lonchopteridae, and Asilidae seem to have retained the dichoptic eyes, and examples of both conditions are met with in the Empidae.

There are no examples in the Muscidae which have such extreme development as the Pipunculidae, although the majority of males are distinguished by the holoptic character; but in the Acalyptrates many have retained the dichoptic eyes.

2. *The Divided Eye of the Male.*

This I know of only in the Bibionidae, although there are certain Coleoptera (the Gyrinidae) which have a somewhat similar structure. It is, however, not a sexual character.

In *Bibio* and *Dilophus* the lower portion of the compound eye is divided from the upper, and appears as a separate part, with its lenses looking downwards. There is, however, another difference, which is not so easily noticed, and that is that the facets of the lower portion are considerably smaller in size than those of the upper. A measurement of the parts in *Bibio hortulanus* gave me a proportion of eight units for the upper facets, as against five units in the lower facets; five units appears to be the normal size, as all parts of the eye of the female gave this measurement. The eyes of *Dilophus febrilis* were also measured, and gave similar proportions and results.

The facets in the eye of the male were also measured in two undetermined species, one from New Zealand, and a similar proportion was found to exist.

Dilophus nigrostigma, a very large species (proportionally), shows a band of chitin which separates the two divisions of the eye, and I have given a figure of a small portion (Fig. 12).

3. *Variations in the Size of the Lenses (Facets) of the Eyes.*

This is a character which, until I found it on the head of a single female of *Leptogaster* (an Asilid), I thought was confined

exclusively to the male sex; it seems to me to have arisen in much the same way as the double eye of *Bibio*.

The differences in the size of the facets of the male eyes have been noticed and made use of as specific characters. Schiner says that the lower facets of the male of *Tabanus sudeticus*, Zlr., are very much smaller than the upper—"Untere Facetten des Männchen auffallend kleiner als die oberen"*—and mentions a similar character in seven other males of his genus *Tabanus*; but he does not give it in *Haematopota*, where, however, it is a microscopic character. I have already noticed the remarkable nature of the differences in *H. pluvialis*, and I have made a number of observations which show that the character is not uncommon.

Bibio and *Dilophus* have already been described. *Simulium ornatum*, F., has the facets in front of the head very much larger than those lower down (Figs. 6, 7).

The following males in the Stratiomyidae all have a similar character: *Chloromyia formosa*, Scof., *Michrochrysa polita*, L., and *Chorisops tibialis*, Mg.

In *Leptis conspicua*, Mg., the front lenses are slightly larger than the lower.

In the Syrphidae I can point out a number of cases: *Platychirus peltatus*, Mg., *Cnedemon vitripennis*, Mg., *Syrphus ribesii*, L., *Rhingia campestris*, Mg., *Helophilus pendulus*, L., *Xylota segnis*, L., and *Syritta pipiens*, L. These vary in proportion from being only slightly larger in *Helophilus pendulus* to being more than double the size in *Syritta pipiens*, the difference being thirteen units in the largest and six in the smallest.

4. *Eyes Situated on Lateral Projections.*

This is a character of the Diopsidae, a Muscid family, and therefore not only specialised as to eye-structure, but also in this curious adaptation. In the males of some species the eyes are placed so far apart that a measurement from eye to eye shows a greater distance than a measurement from the head to the

* *Die Fliegen*, vol. i. p. 34, 1862.

opposite extremity of the abdomen (*Diopsis apicalis*). In the females it is considerably less, and species are found with many degrees of extension, in some the stalks of the eyes being stout and short. It is a widely distributed family, as examples are found in North America, in West and South Africa, and in Ceylon.

The lenses are of the usual type found in the Muscidae, without any opaque structure; but the eye-surface is greater (and this in both sexes) than in Diptera of similar size.

5. *The Pubescence on the Eyes.*

This is found in a large number of cases equally developed in both sexes, as in genera of the families Mycetophilidae, Dolichopodidae, Syrphidae, and Muscidae; but there are many species in which it is a sexual character.

In the Nemocera, when pubescence is present as a non-sexual character, the hairs are short and stiff, sharply pointed, and obviously socketed in the subquadrate space between four lenses, and a similar condition can be seen in many Dolichopodidae in the Brachycera. But in *Bibio*, where the pubescence is a male sexual character, the eyes of the females being bare, they are thin, weak, but very numerous, and of extreme and unusual length.

In *Haematopota* it is a sexual character, as the eyes of the female are only very faintly pubescent or bare, while the greater part of the eyes of the males are thickly haired. *H. pluvialis*, ♂, has the chitinous facets of the eyes thinly haired, but where the structure has disappeared the hairs are long and numerous—two to each facet, as against one to four facets in the chitinous area. The eyes of *H. pluvialis*, ♀, are bare, and *H. crassicornis*, Whlb., ♀, and *H. italica*, Mg., ♀, have only a few scattered hairs on these organs.

In the Anthomyid genus *Hyetodesia* there are some cases in which the pubescence on the eyes of the females is shorter or much less than on the eyes of the other sex. *Hyetodesia dispar*, Fln., *H. umbratica*, Mg., *H. perdita*, Mg., *H. erratica*, Fln., *H. basalis*, Z., *H. rufipalpis*, Mcq., and *H. lasiophthalma*, Mcq., are examples.

There are examples in the Ephydrid Hydrellinae of pubescent eyes, but these are common to both sexes; I mention the fact as this group retain some very archaic characters in the mouth parts, and it bears on a later argument.

On the Uses or Advantages of these Adaptations, and the Causes that have led to them.

1. *The Holoptic and Dichoptic Eyes.*

It seems agreed that a larger surface of eye-space is of advantage to the possessor. It is also obvious, from that condition prevailing in the Nemocera, that the dichoptic condition is the primitive one, and that those families or genera exhibiting it simply retain the ancient character. Space will not admit of an inquiry into the causes that have prevented the acquirement of the holoptic eyes, but I will mention that in the case of the familiar crane-flies the males often possess longer legs than the females; so it may be that the struggle for the possession of the female does not depend so much on sight as speed. That there is a fierce struggle we know, as Westwood has recorded several instances of the males of Tipula having been seen fighting.*

2 and 3. *The Division of the Eyes and the Variations in the Sizes of the Lenses.*

An examination of the eyes of most insects will show that they can only command a limited view of what is beneath the head. In *Bibio* and *Dilophus* this limited view is further interfered with by the palpi, which are long and four-jointed. The modification of the eyes of the male in these genera gives him an increased power of vision in this direction, and, as we have seen, he uses the smaller or normal facets in the lower division of the eye.

The eyes of the females, particularly in *Dilophus*, are but small masses in proportion to the size of the body; and as at one period

* "Modern Classification of Insects," vol. ii., 1840, p. 526.

of evolution the eyes of the males were no larger, the gradual acquirement of the character as we now find it must have been of great advantage.

We see, in the related *Scatopse*, that the eyes of both the sexes have proportionately enormously increased; therefore this character would not be of the particular advantage in these flies that it is in *Bibio* and *Dilophus*, and consequently has not established itself in the genus or in the other families of the order. The influence of the character of the genitalia in these genera will be referred to later.

The second problem before us is, What part do the larger facets play? Are they simply caused by an enlargement of space—*i.e.* a spreading out of the lenses to take up the larger surface of the holoptic eye? It is certainly the fact that these larger facets cover the areas which are bare of facets in the female; but as we find the whole head completely covered with facets in Oncodes, and there is no difference, either sexual or in the sizes of the lenses, these facts negative the idea.

Or are they modified to give the male a long and a short sight, that is to say, two foci of vision? Do the smaller afford a more powerful magnification, possibly a means of discrimination, so that the true species is mated with?

The females in *Bibio* are in many species dark red, or, at any rate, differ in colour from the males, which are a deep black; and some connection might be thought to exist between the colour and the highly modified sight, but this is at once put out of consideration by the fact that the females of *Dilophus* are as black as the males. It has occurred to me that the double eye might have arisen as a compensation for the failure of another sense, such as the olfactory pits on the antennae or the sense-organs that are sometimes found on the male genitalia; for instance, those on the forcipes inferiores of *Tipula oleracea*, L.

The number of joints in the antennae appear variable, especially in *Dilophus*, and though the olfactory organs are very well marked in the males, they are even more marked in

the females, and I cannot find any unusual sense organs in the genitalia.

In *Bibio* the genitalia are of a simple type, and in *Dilophus* even more degenerate, and there appear to be no mechanical impediments to prevent the union of many species of the same genus; nor are there any special sense-organs which might be thought to fulfil such a function, as we find in *Tipula*, where similar conditions exist. In these two cases the double eyes, and the two sizes of facets (if the means of discrimination, and therefore of the isolation of the species) would, as I have already pointed out, be of obvious advantage.

Weighing all these arguments, particularly the fact that the lower parts of the eyes in *Bibio* and *Dilophus* would look directly down on their partners in *coitus*, and remembering the innumerable contrivances in nature to secure isolation, I am inclined to think that the larger facets enable the male to see his mate at a distance, while the normal facets (normal as they are found in both sexes) enable him to recognise her with greater certainty when quite close.

The presence of the two sizes of facets on the female of *Leptogaster cylindrica*, Deg., does not help to any solution. I have only this solitary example of this genus in my cabinet, and it may be one of those interesting cases of the acquirement of a character belonging to the opposite sex, or, on the other hand, it may be of great advantage to its possessor, this insect being fiercely predaceous.

It will be noticed that all the species possessing two-sized facets, except in the Bibionidae, where the double eye is found, are insects with the eyes in chitinous frames, and it is possible that the sight is not so good as in the Muscidae, and that these modifications have arisen in consequence; but I do not think this idea will hold, as I know no quicker or sharper-eyed insect than a Bombylius, and members of the family to which it belongs exhibit a more highly developed chitinous structure than the Syrphidae, which are by no means slow, especially *Helophilus*, as most entomologists have found when collecting.

(4) *Eyes situated on Lateral Projections.*

This character must afford the possessors of it a greater range of view—the whole horizon, in fact, and probably some description of stereoscopic vision in front. It seems to have been brought about by sexual causes, as we find the female much less developed in the spread of the projections (but, I think, equally developed in the size of the eyes). My observations on this point, however, are much too few to speak with any certainty.

(5) *The Pubescence on the Eyes.*

The advantages and disadvantages of this character are, I confess, very difficult to understand. To try to solve the problem I made the following experiments:

Experiment 1.—A number of round holes about 1 mm. in diameter were made in a card, so that the centre of each circle was 3 mm. from the centre of the surrounding circles.

(*a*) This was placed at various distances from the eye. Very little obstruction to vision was met with, and the outline and details of objects about eighty yards off were clearly seen.

(*b*) A strong light was screened, and a small hole was made in the screen, on which the card was placed. The light from the holes was focused on a white surface, and faintly illuminated a much larger space than the 16-mm. square experimented with. The spaces opposite the holes were brightly illuminated, and the areas between the holes were brighter than the surrounding larger space described above.

Experiment 2.—A similar card was prepared with holes at the same distances. Between these holes inch pins of the usual thickness (not entomological) were inserted, and Experiment 1 (*a*) was repeated with surprising results, as the view was scarcely if at all interfered with. Experiment 1 (*b*) was also repeated, the pins turned to the light, and their bright surfaces reflected light, but again no appreciable advantage or disadvantage was experienced.

The conclusion I arrived at was that pubescence has but little to do with the sight. I then considered that it might be protective, and certainly in the case of *Bibio* it may well be so, as the flight of the male is often exceedingly quick and headlong, and the curious sexual fury that finds vent in dances and other antics may cause him to blunder up against hard objects and suffer injury. The long pubescence in this genus would make quite an elastic protective cushion. But there are a number of factors to be taken into consideration; as although we find it so highly developed in the male and so markedly contrasted by its total absence in the female, it seems a character confined to that family, and the much weaker sexual developments in the Tabanidae and *Hyetodesia* may be vestigial.

The character as a non-sexual one is an archaic one, and its presence in so many families in an equal state of development in both sexes seems to point out that it has some advantages, though this idea is difficult to reconcile with its absence in *Bibio* ♀, and its weaker character in the same sex in *Hyetodesia*.

On the whole, I think it is in some cases protective in the male; that the females of *Haematopota* and *Hyetodesia* have partially developed a character of the opposite sex; and in the remaining cases, where it is equally developed in both sexes, that the females have wholly developed the male character, and it has ceased to be sexual. An analogous case to this has occurred in the Cyrtidae in the matter of the size of the eyes.

The Chitinous Structure of the Eyes.

Two cards placed a millimetre apart were pierced in a similar manner to the other cards, so that the rays of light would pass through a dark chamber of greater depth than in the former experiments; a bright light was focused on a card, and the dots of light seemed sharper and more exactly defined than in the previous experiments.

Some arthropods of very archaic type, such as Scolopendra, have only simple eyes, circular apertures pierced in plates of

chitin; and insects are met with having a similar development. I have several undetermined parasites in my cabinet which have such eyes fitted with very globular lenses. From such a condition it is only a short stage to the eyes of some Mycetophilidae, such as the *Sciara* figured (Fig. 4).

The next stage would be that these chitinous divisions would take less room, or interrupt less light; and we see from the third experiment that a depth of the side might be of service in concentrating rays of light. Doubtless many modifications of the original pierced opaque plate with circular apertures arose, till we find in the highly specialised Muscidae that all the non-transparent material of the eye-surface has disappeared. If my hypothesis as to *Haematopota* being close to an ancestral form of the Muscidae is correct—and the condition of the eye gives increased probability to this belief—the fact that in the eye of *H. pluvialis* ♂ we find a transition state is of great significance, and would show that the structure of the Muscid eye, like the pubescence and the complete covering of the head with eyes, is a character inherited from the male, and adopted by both sexes, and that it originally arose from the advantage of increased powers of vision in the male sex.

I have prepared tables giving a rough idea of the varying conditions of the eyes in most of the families of Diptera, and these will, I trust, be of assistance in the comparison of the different types.

Methods of Work.

These structures are best seen in preparations cleared in caustic potash and mounted without pressure; but they can be recognised in those mounted with pressure, although in many cases high powers will be necessary to show the pubescence and the shape of the facets.

The structures on *Haematopota pluvialis* ♂ are best seen if the head is cleared in caustic potash and the eyes dissected out, and flattened (and consequently fractured) on the slip, but here again a whole head mounted with pressure will show them.

Table showing the Condition of the Eyes in the Nemocera.

	Character of chitinous structure	Shape of facets.	Variation of size of facets of ♂.	Character of pubescence when present.	Plates bend round the antennae.	Holoptic or Dichoptic.	Simple eyes (ocelli).
Cecidomyidae	marked.	circular.	?	bare.	—	?	mostly absent.
Mycetophilidae	very marked.	,,	none.	very short hairs and bare.	marked.	D	one occasionally aborted.
Bibionidae: *Bibio hortulanus* ♂	fine line.	hexagonal.	marked.	extremely long.	—	H	three always.
Bibionidae: ,, ,, ♀	almost gone.	,,	none.	bare.	—	H	,, ,,
Bibionidae: *B. marci* ♂	fine line.	,,	marked.	extremely long.	—	H	,, ,,
Bibionidae: *Plecia*	,,	,,	—	short hairs.	—	?	,, ,,
Bibionidae: *Dilophus*	more chitinous.	hexagons close to circles. circles in ♀.	marked.	hairy.	—	H	,, ,,
Bibionidae: *Scatopse*	very marked.	circular.	—	very short.	v. marked.	—	,, ,,
Simulidae	,, ,,	hexagons.	marked.	bare.	—	D	aborted.
Chironomyidae	,, ,,	circular.	—	,,	marked.	D	,,
Psychodidae	,, ,,	,,	—	,,	,,	D	,,
Culicidae: *Corethra*	fairly evident.	,,	—	,,	,,	D	,,
Culicidae: *Mochlonyx*	gone or transparent.	,,	—	,,	,,	D	,,
Culicidae: *Culex*	,,	,,	—	,,	,,	D	,,
Ptychopteridae	very marked.	hexagonal.	—	,,	—	D	,,
Limnobidae: *Erioptera*	marked.	hexagons with angles rounded.	—	,,	—	D	,,
Limnobidae: *Trichocera*	,,	hexagonal.	—	,,	—	D	,,
Tipulidae	very marked.	,,	—	,,	—	D	,,
Rhyphidae	very weak.	,,	—	very short.	—	D	three always.

TABLE SHOWING THE CONDITION OF THE EYES IN THE BRACHYCERA AND CYCLORRAPHA.

	Character of chitinous structure	Shape of facets.	Variation of size of facets.	Character of pubescence when present.	Plates bend round the antennae.	Holoptic or Dichoptic.	Simple eyes (ocelli).
Asilidae	very marked.	hexagonal.	in ♀ Leptogaster.	rare.	—	D	three.
Empidae: *Clinocera*	,, ,,	hexagonal but minute.	—	short, plentiful.	—	D	,,
Empidae: *Pachymera*	visible.	,, ,, ,,	—	bare.	—	D	,,
Empidae: *Hybos*	gone.	,, ,, ,,	—	,,	—	—	,,
Dolichopodidae	faint to fairly marked.	often squares minute hexagons.	—	very short, but plentiful, one at each angle of facets.	—	H	,,
Phoridae	as above.	circles and hexagons.	—	as above.	—	D	,,
Lonchopteridae	marked.	rounded hexagons	—	bare.	—	D	,,
Leptidae	,,	hexagonal.	slightly larger in ♂ occasionally.	,,	—	H	,,
Stratiomyidae	,,	,,	many ♂.	hairy in many.	—	H exceptions.	,,
Tabanidae: *Tabanus*	very marked.	,,	,, ,,	more or less.	—	H	aborted.
Tabanidae: *Chrysops*	much less marked ♀.	,,		often present.	—	H	three.
Tabanidae: *Haematopota*	transitional ♂.	,,	♂ two sizes.	very hairy ♂.	—	H	aborted.
Tabanidae: *Pangonia*	marked.	,,	,, ,,	bare.	—	H	three.
Bombylius	,,	,,	,, ,,	very hairy.	—	H	,,
Cyrtidae	—	—	—	some of both.	—	—	mostly present, absent in one genus.
Oncodes	marked.	hexagonal.	—	bare.	—	—	two present.
Platypezidae	almost gone.	minute, hexagonal	—	,,	—	D *	three.
Pipunculidae	gone.	,, ,,	—	,,	—	H	,,
Syrphidae	marked.	hexagons.	often very marked in ♂.	some of both.	—	H	,,
Conopodae	gone.	,,	—	bare.	—	D	present and aborted.
Muscidae	,,	,,	—	many of both.	—	H D	three.

* *Optia* exceptional.

Explanation of Plate 28.

Fig. 1. Portions of the eyes of a Cecidomyid, highly magnified. The section drawn is on the top of the head, and shows parts of both eyes, the bare area in the middle being the median line.

„ 2. Head of *Bibio hortulanus*, L., ♂, drawn at a low magnification. A lateral view is given; *a* indicates the situation of the lower eye.

„ 3. Part of an eye of *Sciara thomae*, L. To show the chitinous plate pierced with round apertures for the lenses, and the short pubescence characteristic of the Mycetophilidae.

„ 4. Edge of the eye of an undetermined *Sciara*, to show the hyaline structure of the lenses.

„ 5. Part of an eye of *Dilophus febrilis*, L., ♂, showing the larger facets.

„ 6. The smaller facets on an eye of *Simulium ornatum*, Mg., ♂, drawn to the same scale as Fig. 7, and for comparison with it.

„ 7. The larger or upper facets of *Simulium ornatum*, ♂.

„ 8. Part of an eye of *Haematopota pluvialis*, L., ♂, showing the chitinous lower structure with smaller facets, and the transition area merging into the larger facets, where the opaque structure is obliterated.

„ 9. Part of an eye of *Tipula oleracea*, L.

„ 10. Part of an eye of *Calliphora erythrocephala*, Mg.

„ 11. Part of an eye of *Chironomus dorsalis*, Mg., showing the upper portion of the plate where it bends round the antennae.

„ 12. Part of a double eye of *Dilophus nigrostigma*, Hutton, ♂, a New Zealand Bibionid. To show the chitinous structure separating the upper from the lower eye. The larger lenses are in the upper eye.

„ 13. Edge of the eye of *Bibio hortulanus* ♂, to show the pubescence, which is, however, often much thicker, as hairs not socketed in the field of vision have been omitted.

ON *HOLOSTOMUM EXCISUM* (LINSTOW, 1906), AND THE DEVELOPMENT OF A TETRACOTYLIFORM LARVA TO A *HOLOSTOMUM* sp.

By T. B. Rosseter, F.R.M.S.

(*Read March 5th*, 1909.)

Plate 29.

Part I.

In describing the method of fructification in *Hymenolepis acicula sinuata*, in a footnote to my paper on that species of tapeworm, I pointed out an affinity that existed between it and *Holostomum excisum*, Linstow, in consequence of the method of transmission of the spermatozoa, and the laurer canal existing in the Trematoda and the functional uses of this organ as demonstrated by O. von Linstow in his description of *Holostomum excisum*. It is not my intention to enter into any explanation either by way of argument or in substantiation of O. von Linstow's diagnosis and description of the anatomy of this Platyhelminth ; but as the accompanying plate illustrates what I consider to be the final stage in the evolution of a *Holostomum* (and which at the outset I would remark is the object of my paper), it is my intention to give a condensed translation of O. von Linstow's researches, and a description of his new species of *Holostomum*. Perhaps, therefore, some apology is due from me to the members of the Quekett Club in general and O. von Linstow in particular. There are points in the anatomical details to which objection might perhaps be taken, but such a course would, under the circumstances, be unjustifiable in this article. I may say that in the matter of the laurer canal, as applied to the Holostomidae (consequently the Trematodae) by von Linstow, I am quite in accord with him. Von Linstow took this species of *Holostomum* from the intestine of *Aegolius otis* and *Strix flammea*, two species of owls.

His description concisely translated is as follows :

" Body 3·17 mm. long ; anterior portion 1·06 mm. long, 0·99 mm. broad. The back portion is curved, and the posterior or tail end is rounded.

"The acetabulum, or mouth-sucker, is 0·15 mm. in diameter; continuous from this is a bowl-shaped pharynx and the intestines. The ventral sucker lies distally in the middle of the head cavity, and has a diameter of 0·31 mm. The cavity or cleft of the head is practically filled with these two suckers, which are joined together by a muscular belt (or, as von Linstow calls it, a bridge). Each of these suckers possesses a spur-like protuberance.* Two long muscles which commence at the dorso-anterior portion of the head continue their course (on either lateral border) to the extreme posterior end of the body.

"There are two large testes, one anterior and one posterior. The shell gland, which is nearly square, divides the two testes and spreads itself out anteriorly and posteriorly of them. The vesicula seminalis is a winding duct situated behind the posterior testis, but anterior of the stoma of the uterine aperture.

"The receptaculum seminis is pyriform, and is situated dorso-median (in the body parenchyma), on the posterior side of the ovarium. The vitellaria runs the whole length of the creature from the head to the tail, and is located more especially on the ventral side.† The ductus vitellus runs between both testes, and is covered by the shell gland.

"The orifice of the laurer canal is posterior to the ovary—keimstock—on the dorsal side. Its lumen is 0·016 mm. in length, and one μ in breadth. The oviduct makes a junction with the shell gland dorsal of the intestine, and runs along the ventral side of the anterior testis.

"The uterus has a short ascending and a long descending duct. It is connected with the shell-gland, and its tract lies through the posterior portion of the body. It then runs ventrally and terminates distally in the uterus bowl or cylinder. This cylinder is a muscular tube perforated through the middle of the canal, and surrounds the body wall in the form of a preputium. It occupies one-fifth of the posterior portion of the body. The eggs are golden-coloured, 0·10 mm. long and 0·075—0·078 mm. broad."

* Von Linstow makes no mention of a lobe or gland which I find at the terminative end of each spur.

† In my specimens of *H. excisum* and other species of Holostomidae, I find that the vitellaria is confined to the arched posterior portion of the body and lies dorsally and ventrally.

O. von Linstow further states that he has always believed that the laurer canal performed the functions of a vagina, and that the anatomy of this new species *Holostomum excisum* showed the impossibility of this, for in that species there are no signs of a cirrus existing. The sperm is evolved at the posterior end of the body (from the endodermic cells) which becomes a duct, and by means of this duct it is conveyed to the uterus. Thus if in this species the laurer canal possesses the function of a vagina, then, under similar circumstances, it is applicable to other species of Distomidae.

Von Linstow illustrates his article with three figures. All these figures are sectional, and valuable anatomically, but they by no means show the natural beauty of this *Holostomum.*

I took this fine worm in the first instance from amongst the contents of the alimentary tract of a teal (*Anas creca,* Linn.) during the winter of 1906 and 1907. I prepared, stained, and mounted my specimens, but did not make any sections. I also studied the species and prepared a paper for insertion in the *Quekett Journal.* I was unaware until von Linstow sent me his published work that he had already described and figured the species. I have consequently withdrawn the proposed paper, and have substituted the conclusions of von Linstow in place of my own. Although, of course, disappointing, it is some satisfaction to know that in the main one's own observations coincide with those of a previous investigator.

Part II.

In the *Jenaischen Zeitschrift für Naturwissenschaft,* 28 Bd., N.F. 21, Taf. 22, Figs. 1–8 (Jena, 1894), O. von Linstow contributes an article on "*Tetracotyla typica,* Dies.," which I take it he considers to be the larval stage of a *Holostomum* which he found in an encysted form in the liver of *Limnaea stagnalis* taken from a lake in the neighbourhood of Göttingen. In this article he quotes and explains the views of various authors who have written on the larval or cystic forms of Trematoda, viz. Creplin, Steenstrup, Schomburgk, De Filippi, Pagenstecher (see Cobbold's *Parasites of Man and Animals*), Diesing, and Ercolani. He also gives a detailed account of the various slugs which he found acting as host to this cyst. He lucidly describes the contour of

the oval body, the motile and inert stage, and also the inert capsuled stage; but here the transition ends.

This important and masterly work of Linstow on *Tetracotyla typica* seems to me to be a justification of a previous paper by the same author (with which I am unacquainted) and concerning which Dr. G. Brandes, in "Die Familie des Holostomidae," *Zool. Jahrbücher* (Jena, 1890), questions the accuracy of Linstow's conclusions as regards the development of the egg into a ciliated embryo and then into an embryonic or larval Tetracotyle. Dr. Brandes admits that in Kuchenmeister's diagnosis of the changing embryo there are points which refer to its Tetracotyle development. He is not satisfied, however, with Ercolani's assertion of his having produced a *Holostomum* by feeding ducks and sparrows on molluscs infested with *Tetracotyla typica*. Further, he is not in accord with von Linstow's theory of cell development. He had hoped to fill up the gaps left by Linstow, but says his eggs were attacked by a fungoid growth, and destroyed. Nevertheless, he was in a position to state that at the most only a second division of the nucleus takes place; that rejuvenation occurs (between the yelk cells at the pole of the eggs); and that he could substantiate Schauinsland's assertion that the protoplasm participates in the division of the nucleus. Brandes frankly states that in his day much that had been written on the development of the family Holostomidae was exaggerated. The knowledge of the circumstances attending the change from the larva to the sexually mature *Holostomum* was no more advanced than that concerning the embryo; and apart from Ercolani's single sketch of the largely increased body of the *Holostomum* (which he questions) he admits that he has nothing new to add. He relates how he had fed an owl (*Otis vulgaris*) with horseflesh containing six specimens of *Tetracotyla* taken from the tissue of a ringed snake (*Tropidonotus natrix*), but unfortunately his owl died prematurely, and although in the autopsy he did find a questionable specimen of *Holostomum* in the intestine, he attached no importance to it, as it did not prove the metamorphosis of the *Tetracotyla* into a sexually mature *Holostomum* or *Diplostomum*. In his own mind Brandes is not sure that the owl is the true host for the development of the *Tetracotyla*, and it certainly requires more than one feeding experiment to demonstrate the different stages of

development from the tetracotyliform larva to the sexually mature animal.

The supposition of the owl being one of the hosts of this platyhelminth is the most probable, as von Linstow took his specimens of *H. excisum* from two species of owl.

The species of the family of Holostomidae are amongst the handsomest of the Distomidae group, not only from the shape of their bodies, but likewise from the internal anatomy, which sharply separates them from the other species of Trematodes. The peculiarity of a Holostomid is that in its development the body undergoes a transformation, so that it is divided into two separate bodies—an anterior and a posterior.

Brandes recognises three types: 1st, the Leaf or Simple type (*Diplostomum longum*); 2nd, the Spoon type (*Haemastomum clathratum*); 3rd, the Goblet or Beaker type (*Holostomum*); but with these types we need not at present concern ourselves. My object is to take up von Linstow's *Tetracotyla*, and endeavour by means of my own specimens to show concisely the development of this stage after it has arrived at its final host. It was an accidental but fortunate circumstance that called my attention to, and suggested further investigation of, this subject, so that I can take no credit for the results obtained, beyond that which may be due for patient, sedulous work, in spite of the unpleasantness and tediousness of the examination of the sedimentary substance from the alimentary tract. It was whilst so engaged in re-examining the various objects that had been selected from my precipitating pans, amongst which were specimens of this beautiful form of Trematoda, that I was struck with the similarity of some minute plasmic forms to von Linstow's fig. 1 of *Tetracotyla typica* (Plate 29, Fig. 17); so the remainder of the contents of the intestine of this particular teal was carefully examined, and by this means I was enabled to build up and mount on a single slide the progressive stages of the development of this platyhelminth (a *Holostomum*) from the point at which von Linstow leaves it, and at which Brandes' feeding experiment failed him.* In other words, I have demonstrated the development and growth of the different stages from the *Tetracotyla* to the sexually mature animal.

Besides the teal, I have found the Holostomidae parasitically in the wild duck, wigeon, jay, blackbird, and starling.

* This slide was exhibited at the meeting of March 5th, 1909.

Whilst agreeing with Brandes that the most positive evidence of the evolution of a Holostomid from a tetracotyliform larva is only to be arrived at by successive experimental feeding of a known host with the larvae, and thus raising the sexually mature animal, still, in the absence of such an experiment having been accomplished in the past, and the want, so far as I am concerned, of material to enable me to undertake a series of experiments with such an ulterior object, having obtained what, in my opinion, are obviously the several stages of its development from a Tetracotyla to the mature worm, I feel justified in publishing these facts as a continuation of von Linstow's work.

In this species of *Holostomum* the ovary (Fig. 10, O.) lies in close proximity to the neck. It is partially covered posteriorly by the receptaculum seminis (Fig. 10, R.S.). Both of these are semi-globular. The latter is the swollen sac of the sinuous laurer canal, whose pore performs the function of a vagina for the reception of the sperm (Figs. 10 and 16, L.C.). The shell gland (Fig. 10, S.G.) is oval, and occupies the median vertical portion of the body. The vitellaria (Figs. 5–13) extends from the head to within a short distance of the caudal end. It is located dextrally and sinistrally in the cavity of the body, and partially covers—and by the density of its pigmentary glands conceals—the whole of the genital tract. The yelk duct runs vertically over the shell gland. Its centre is swollen, and forms a sac, the yelk reservoir (Fig. 10, Y.R.), whilst its terminative ends, proximally and distally, taper off into thin filiform ducts, which curve on either side and then bifurcate. Into these are poured the yelk substance from the glands, it being then passed on to the reservoir. The ovarian duct passes laterally posteriorly, dorsal of the anterior testis, and previous to its entering the shell glands makes a junction with the ductus efferentia (or fertilising canal). The uterine canal, when it leaves the shell gland, descends to the dorsal cavity, along which the uterus is formed and into which the golden-coloured eggs are passed (Fig. 10, U. and OVA). There is never at any time a multiplicity of eggs deposited in the uterus. At the proximal pole of the egg there is an operculum. Each egg has a polar length of 0·084 mm., and transversely measures 0·05 mm.

There are two ellipsoidal testes. They are separated anteriorly and posteriorly by the shell gland (Fig. 10, T.) I have not

been able to trace their efferent ducts to the vesicula seminalis (Fig. 10, v.s.) This is a long swollen sinuous duct, the basal end of which is semi-pyriform; and as it runs upwards along the ventral border carrying the spermatozoa, it gradually becomes thinner and finally makes a junction with the pore and discharges the sperm into the laurer canal, thus filling the receptaculum seminis (Fig 10).

Thus it will be seen that in this species, as in von Linstow's *Holostomum excisum*, no male organ of copulation (cirrus) exists, and in this respect this Trematode is analogous to, and has an affinity with, *Hymenolepis acicula sinuata.*

In this species of *Holostomum* there is no side cavity or cleft as in *H. excisum*, but the cavity exists as a cup whose peristome, in its early stage, is subspherical (Figs. 1–4). As development proceeds, however, the periphery becomes crenate, and in the perfected or sexually mature creature we have a distinctly crenate calyx, or cup. The genital papilla at the posterior or caudal end is not protruded until the genital organs are matured. It is capable of evertion and invertion, and I am in accord with von Linstow in believing that its function is that of a uterus cylinder for the deposition of the ova. Dujardin, *Hist. des Helminth.*, p. 372, No. 10, somewhat dubiously refers to Rudolphi's statement of his having seen in *Amphistoma* (*Holostomum*) *cornuta* such a phenomenon, viz. the evertion of the "Corne" and deposition of the ova, and its retraction after the act. Fig. 15 is from a specimen in my cabinet in which the creature is seen in the act of depositing the ova through this cylinder.

Description of Plate 29.

Fig. 1. This has been reconstructed, and as seen in the mounted specimens would raise a doubt in the investigator's mind as to its being the primary stage of the released embryo, but of this I have no doubt. In passing it through the various grades of dilute glycerine to its final mounting-medium, pure glycerine, it became unfortunately mutilated. The primitive mouth-sucker is plainly visible. × 45.

Fig. 2. This coincides with Fig. 1 of von Linstow's young form of *Tetracotyla typica* (Fig. 17). × 45.

Figs. 3 and 4. Further developments of the same. In these specimens no trace can be discerned of the anlage of the hermaphroditic genitalia. The looped intestine can be traced some distance down from the mouth-sucker into the posterior or body portion of the creature, also the terminative excretory pore. × 45.

Figs. 5, 6, 7, and 9. These illustrate the progressive advancement in the perfection of the sexually mature *Holostomum*. Of the female genitalia, only the vitellaria is plainly visible. In consequence of the pigmentary character of the glandular corpuscles, which are closely aggregated, the other organs of generation are in a great measure obscured. × 45.

Fig. 8. A dorsal view of Fig. 6. × 45.

Fig. 10. Sexually mature creature. × 45.

Figs. 11, 12, and 13. Prepared specimens of *Holostomum excisum*, von Linstow, 1906, and Fig. 14 is a young specimen of Fig. 13. In this young *Holostomum* the pore of the laurer canal can be defined, also some of the ducts of the developing genitalia. × 45.

Fig. 15. Caudal end of specimen, showing the deposition of ova through the uterine papillus. × 45.

Fig. 16. Laurer canal with spermatozoa in the pore. From compressed specimen, the pressure causing the vesicula seminalis to be ruptured, leaving one broken end in the pore. × 220.

Fig. 17. Young form of *Tetracotyla typica*, after von Linstow.

Abbreviations as follows:—E.P. excretory pore; G.P. genital papilla; L.C. laurer canal; M. mouth; O. ovary; P.L.C. pore of laurer canal; R.S. receptaculum seminis; S.G. shell gland; Sp. sperm; S.S. side suckers; T. testes; U. uterus; U.A. uterine aperture; V.S. (in Figs. 2, 3, and 4) ventral sucker; V.S. (in Fig. 10) vesicula seminalis; V. vitellaria; Y.G. yelk gland; Y.R. yelk reservoir.

HYMENOLEPIS ACICULA SINUATA, A NEW SPECIES OF TAPEWORM.

By T. B. Rosseter, F.R.M.S.

(*Read March 5th*, 1909.)

Plate 30.

This tapeworm was taken from the intestine of *Anas boschas fera*, commensal with other species of tapeworms.

Including the scolex and neck it is 59·063—60 mm. in length. Its segments throughout the strobila are broader than long. The scolex is an elongated truncated cone (Plate 30, Fig. 1) 0·304 mm. in length, its greatest width 0·262 mm. Its apex at the inversion of the rostellum has a diameter of 0·067 mm., whilst the diameter of the transverse ridge is 0·185 mm. There are four oval suckers approximately 0·169 mm. long. The rostellum is pyriform, 0·203 mm. in length and 0·106 mm. in diameter; it bears ten sickle-shaped hooks, 0·067—0·068 mm. in length (Figs. 1 and 14). The neck is short, rugose, and can apparently be elongated. The collar at the base of the neck is duplex. The primus is 0·05 long and 0·236 broad; the secundus 0·34 long and 0·236 broad. Segmentation commences immediately behind the collar. The segments are aggregated or closely pressed together, and are the same breadth as the neck for some distance, when the segments become more distinct and have a length of 0·034 mm. and a breadth of 0·371 mm. It may be advisable to mention here that the segments throughout the strobila are, until the six-hooked brood is perfected, very short and very broad, and in this respect resemble those of *Taenia perfoliata*. The early-formed genital segments are 0·034 mm. long and 0·474 mm. broad. The mature hermaphroditic segments are 0·05 mm. long and 0·792 broad, whilst the changing

uterine segments increase in size to 0·084 mm. in length and 1·056 mm. in breadth, which is their maximum width. On the development of the six-hooked brood a radical change takes place in the formative character of the proglottides, the segments becoming longer and narrower—for example, 0·247 mm. in length by 0·695 mm. in breadth, and 0·304 mm. by 0·810 mm. The penultimate segment is barren, whilst the ultimate is nearly a square (0·273 mm. by 0·378 mm.), and as this segment is not rounded at its base I assume that segregation has taken place (Figs. 2–9).

The genital copulatory organs are unilateral in the segments.

There is no genital cloaca, but the genital sinus is a *cul-de-sac*. By this I intend it to be understood that there is no exterior genital pore in the parenchymatous tissue of the hermaphroditic segments (as is usual in the genus *Taenia*), for the purpose of copulation.

The male is anterior to the female, and both are contiguous.

Throughout the strobila the male and female organs of copulation, with a few exceptions, are from their inception situated 0·034 mm. from the lateral border. Some are situated farther away than this, but the above is the rule, and in the exceptional segments the genital organs—male and female—have not actually pushed their way onwards through the tissue to the lateral border. Both organs are developed side by side in the same plane in the segment (about 6 mm. from the scolex), and in their earliest stage appear as minute stellate bodies with rays about 2 mm. in length. During their development they remain in contact until about 1 mm. farther down the strobila, when a fission takes place. The male organ, in the form of a funnel with an overlapping rim to its pore, and a long infundibulum (a continuation of the ductus efferentia of the vesicula seminalis), separates itself distally from the female. This act of fission is not complete, the membranous tissue during separation being arrested proximally at the periphery of both genital pores and thus attaching them, the male posteriorly to the female

anteriorly. The male organ pushing its way slightly upwards causes the female organ to lie somewhat obliquely in the segment. Nine millimetres from the scolex there occurs a break in the genitalia caused by six barren segments.

There are two semi-globose testes (Fig. 10, T.) situated in the median transverse posterior portion of the segment, which, when fully developed, have a diameter of 0·05 mm. Their efferent ducts run vertically, coalescing and then curving distally to form the vas deferens, which again curves proximally, and, dilating, forms the vesicula seminalis, a long narrow sac 0·17 mm. long and, when filled with sperm, 0·017 mm. in diameter. Then follows a long tortuous seminal duct deeply embedded in the tissue, and this, bifurcating, forms the membrane of the male genital organ. The ductus efferentia becoming the infundibulum or canal, and gradually widening, forms the inverted hollow cone of the funicular male organ. Its length is 0·037 mm., with a pore diameter of 0·007 mm.

The female tract (Fig. 11) commences with a vestibule, which is an inverted vertically-ribbed cone with a pore diameter of 0·007—0·008 mm. and a depth of 0·024 mm., the intercostals being filled with a diaphanous tissue. At its apex is a narrow canal, the vagina, which leads into an elongated semi-oval vesicle or lumen, somewhat indented at its side, and composed of the same diaphanous tissue as the intercostals. Thus it is vase-shaped, and from an orifice at its distal end proceeds the vaginal canal, which is a long narrow duct ending in a pyriform receptaculum seminis. Midway down the canal is a bulbous vesicle which undoubtedly acts as a contractile organ to accelerate or retard the flow of the sperm. There are two pyriform ovaries situated sub-median in the segment, with a length of 0·06 mm. and a basal diameter of 0·024 mm. respectively. The basal end of each ovary is at the extreme boundary, proximally and distally of the prescribed limit occupied by the female genitalia in the middle of the segment, about 0·278 mm. from each lateral border. There is a wide space between each ovary which

is occupied posteriorly by the reniform yelk-gland, 0·05 mm. long and 0·013 mm. in diameter. The shell-gland lies proximal of the receptaculum seminis, which it partially covers dorsally. The oviducts are straight efferent ducts, deflecting only when the fructifying canal and the duct of the shell-gland make a junction with them.

The ovarian eggs *in uteri* immediately after fertilisation are orbicular, approximately 0·004 mm. in diameter.

The uterus (Figs. 6–9) in its early stage is an elongated sac and occupies transversely 0·473 mm. of the segment; but as the six-hooked brood develops and becomes perfected the segment is filled and becomes a uterine sac. Its boundary walls, which are rounded proximally and distally, are the longitudinal dorsal and ventral excretory canals.

The ovum containing the perfected six-hooked brood is composed of three envelopes (Figs. 12, 13), the outer one being an elongated oval, its polar axis 0·091 mm. and its equatorial diameter 0·034 mm. The lateral borders of the second envelope are drawn out or constricted, 0·074 mm. by 0·027 mm.; the third envelope is ovular, and encloses the embryo 0·047 mm. by 0·017 mm.; whilst the embryo or hexacanth stage is 0·041 mm. by 0·014 mm. The embryonic hooks are 0·013 mm. in length.

The above is but a brief description of the genitalia as they exist in the segment.

The method of propagation (Fig. 16) in this tape-worm presents such peculiarities in contradistinction to any species of *Taenia* with which I am acquainted that it requires special elucidation, and in order to do this I must of necessity refer back to the anatomical details of the male genital apparatus. Thus in the above description it will be noticed that I have refrained from designating the male copulatory organ by the usual appellation of cirrus with its concomitant sheath and pouch (or *bursae copulatrix*), simply because, as will be seen in the sequel, in this instance no such organ physiologically exists. The minuteness and insignificance of the male organ of fructification renders it

a very difficult one microscopically and morphclogically to elucidate; however, the difficulty has been overcome, and the following is a concise description of the result.

When the efferent canal of the vesicula seminalis dilates, and the cuticle bifurcates so as to form the membrane of the male genital organs on the one hand and the ductus of the funnel-shaped male organ on the other, in the place of what would under other or normal conditions have been the cirrus sheath a truncated cone-shaped telescopic apparatus is formed in the interior of the distal portion of the hollow of the funnel through which the duct of the efferent canal of the vesicula seminalis passes, and its orifice forms an emissary pore. This apparatus is studded anteriorly with what are apparently minute spicules, which, when the cone is everted, are seen to be situated on the periphery of the emissary pore, and are deflected, giving it an involute appearance. What part they play in the physiological economy of the genital apparatus I am unable to say.

Thus it will readily be seen and comprehended that a cirrus with its accessories as a copulatory organ does not exist in this species of tapeworm.

When the vesicula seminalis is distended and filled to repletion with sperm, a prolapsus ensues, caused by tension on the surrounding parenchymatous tissue; then the propelled semen rushes forward along the ductus efferentia through the narrow inner duct of the funnel, and the telescopic conical-shaped apparatus mentioned above is forced out in the form of a truncated cone, the sperm being emitted through the emissary pore. In one segment the force of propulsion has been so great as to rupture the cuticle and force out the male organ with the sperm and parenchymatous tissue which lay mingled together anteriorly protruding in the proximal isthmus which separates one segment from the next. Throughout the whole length of the strobila there were no hermaphroditic segments in actual coition to be seen by the aid of a $\frac{1}{6}$-in. objective, and but two which had the male apparatus mentioned above everted. Of

these one was but partially so. In the case of the other the telescopic truncated cone that was everted did not approach or have any tendency to approach the vestibule of the vagina with a view to copulation, but was pushed slightly forward in advance of the vagina. How, then, did the spermatozoa reach the vagina and the vaginal canal in order, as it had done in previous and succeeding segments, to fill the receptaculum seminis? It naturally occurred to me that in the absence of a cirrus there must be a ductus efferentia in some form to carry the sperm on to the vagina.* Patient research, careful manipulation of the light, and the aid of an immersion objective enabled me to determine that the membranous tissue which attaches the male organ to the female runs round the circular rim of the funnel and thus forms a conduit or ductus efferentia to the emissary pore (totally distinct from the dermal wall of the *cul-de-sac*) and in a semicircular form attaching itself at its opposite end to the periphery and costals of the vestibule. Along this semicircular conduit the spermatozoa, which could be traced in the duct, are propelled into the vestibule, through the narrow vagina, thence into the lumen and along the vaginal canal into the receptaculum seminis. Thus in this species of tapeworm no actual act of coition takes place, but merely impregnation in its primitive form of transmission. In the place, therefore, of an elaborate male copulatory apparatus we have a simple infundibuliform canaliculus genitalis.†

There is another characteristic of this tapeworm which requires consideration and explanation. There are ten hooks on the rostellum, these being in number and in every other respect the counterpart of those possessed by *Taenia anatina*. Indeed, so much so in this case that had these hooks been placed before me without any portion or description of the worm from which

* It must be borne in mind that I had but this one specimen to work upon, and that it had been fixed, stained with haematoxylin and safranin, and permanently mounted in glycerine.

† This method of fructification is analogous with that which exists in the Holostomidae, viz. *H. excisum*, and goes to prove the affinity that exists morphologically between the Trematoidae and Cestoidae.

they were taken, and I had been asked to give a decisive opinion as to what species of tapeworm they belonged to, I should have said emphatically, from my previous knowledge, and being as I am in possession of that particular worm as a type-specimen, that they were the hooks from the rostellum of *Taenia anatina*, parasitic in *Anas boschas fera* and *dom.* Indeed, only the fact of seeing the hooks on the rostellum and scolex of the original worm from which they were taken would have convinced me otherwise. This will serve as an admirable illustration of the point I raised in a paper read before the Quekett Club last October as to the internal anatomy of the worm being a most important factor generically, and as to the insufficiency of the formulae propounded by Professor Raillett for determining the genus by the shape of the hooks, important as they necessarily are as an aid to specific identification

TABLE OF DIFFERENCES.

Description.	*Drepanidotaenia anatina.*	*Hymenolepis acicula sinuata*, n. sp.	
Length of worm, including scolex	200–300 mm.	59–60 mm.	
Neck	Long	Short with two collars.	
Greatest breadth of segments	2–3 mm.	1·056 mm.	
Cephalic hooks	Ten, sickle-shaped : 0·065–0·072 mm., *a b* 24, *a c* 72	Ten, sickle-shaped : 0·067–68 mm., *a b* 23, *a c* 67.	
Genital pore	Unilateral : on lateral border of segment	No genital pore, but genitalia are 0·034 from lateral border.	
Male copulatory organ	Cirrus with pouch	No cirrus or cirrus pouch, but a simple canaliculus genitalis.	
Testes	Three : one pore side, two aporose	Two : in middle of segment.	
Eggs, form	Oval with three envelopes	Oval with three envelopes	Ova
1st envelope	Polar axis, 0·125 mm. Equatorial diam., 0·07[illegible] mm.	0·091 mm. 0·034 ,,	
2nd envelope	Polar axis, 0·084 mm. Equatorial diam., 0·02 mm.	0·074 ,, 0·027 ,,	
3rd envelope	Polar axis, 0·057 mm. Equatorial diam., 0·02 mm.	0·047 ,, 0·017 ,,	
Embryo	Polar axis, 0·028 mm. Diam., 0·014 mm.	0·041 ,, 0·014 ,,	
Embryonic hooks	Length, 0·014	0·013 ,,	

The foregoing Table will readily prove to the student in Avian Helminthology that however much the cephalic hooks of each of these worms resemble each other in shape and dimensions, in all other respects the two worms under consideration are totally distinct species; and consequently a new specific name must be allocated to the new one. First, however, it must be dealt with generically.

I am at all times averse to overburdening a family with a superabundance of genera. Simply because one has an isolated specimen of a known group with some unusual (or possibly aberrant) structural peculiarities, such as the ribbed vestibule and intercostal membrane; and the replacement of the normal male copulatory organs by a simple canaliculus genitalis in the present specimen, it does not necessarily follow that one is warranted in classifying it under a new genus.

From the fact of this worm possessing but two globose testes situated sub-median in the segments one would feel induced to place it in the genus *Diorchis*; but in addition to the want of a male copulatory organ, its internal anatomy and formation of the segments agree so accurately with the diagnostic characters of *Hymenolepis*, Weinland, that I cannot do otherwise than place it in that genus. As a justification for so doing I maintain that this method of fructification, hitherto unrecorded in the genus *Taenia*, should be no bar to its entrance into the genus *Hymenolepis*, especially when we consider as a precedent that von Linstow has already, in spite of what I consider equally if not more aberrant physiological conformation, placed his new species *bilateralis* in the genus *Hymenolepis*, admitting, as he does, that "Die Vagina verläuft ventral vom Cirrus-beutel Ein. Receptaculum seminis fehlt. Eier waren noch nicht vorhanden" (*Helminthen der Russischen Polarexpedition* 1900–3. Dr. O. von Linstow, 1905).

Thus if in the opinion of such an authority in helminthology as O. von Linstow the absence of such an organ as the receptaculum seminis does not necessarily demand the transmission of a species from one genus to another, neither in my opinion

ought the method of fructification, even though it be reversive as in the present case, prevent the inclusion of a species in a genus with whose characteristics it otherwise agrees. Especially is this so when we consider that the enclosed vestibule leading to the vagina is expansive, the vagina itself is a narrow canal, and the lumen wide and capacious, corresponding to the anatomical features on which the genus *Hymenolepis* is founded. The costals of the vestibule are not to be explained in the same manner as B. H. Ransom does the ridges and rugae of the cuticula of the vagina of *H. megalops*, Nitzsch (*Studies from the Zoo. Lab. University of Nebraska,* U.S.A., 1892), for instead of being circular they are vertical, thus forming a cone, and are composed apparently of the same skeletal substance as are the hooks on the rostellum. As this portion of the female genitalia from its earliest inception is the most prominent and striking part of the internal anatomy, and although it is *in situ* a vase-shaped organ, still from a superficial observation with a $\frac{1}{2}$-inch objective, or even a $\frac{1}{6}$-inch, the observer would be struck by its similarity in outline to a miniature hair-pin of the form shown in Fig. 17. I propose the name *Hymenolepis acicula sinuata*, for the specific portion of which I am indebted to C. W. Bell, Esq., M.A., of King's School, Canterbury.

Explanation of Plate 30.

Fig. 1. Scolex and neck.
,, 2. Commencing formation of testes.
,, 3. Male segments.
,, 4. Female segments.
,, 5. Early formation of uterus.
,, 6. Uterine segments.
,, 7. Segment with ova developing to hexacanth stage.
,, 8. Six-hooked brood in segment.
,, 9. The three terminative segments. The penultimate segment is barren.

Figs. 1–6 ventral, 7–9 dorsal, all × 50.

Fig. 10. Male organs: T. testes, V.D. vas deferens, V.S. vesicula seminalis, E.D. efferent duct, C.G. canaliculus genitalis, × 400.

„ 11. Female organs: OV. ovaries, Y.G. yelk gland, S.G. shell gland, R.S. receptaculum seminis, V.C. vaginal canal, VG. vagina, V. vestibule, × 260.

„ 12. Egg or six-hooked brood, × 260.

„ 13. „ „ „ of *T. anatina*, after Krabbe, × 240.

„ 14. Single hook from scolex, × 260. The proportion of *a–b* to *a–c* is 23 to 67.

„ 15. Male and female genital organs *in situ*—diagrammatic.

„ 16. This figure shows how fructification takes place as seen with a $\frac{1}{16}$-inch immersion objective—diagrammatic.

„ 17. Crinkled hair-pin.

ON A NEW SPECIES OF TECHNITELLA FROM THE NORTH SEA, WITH SOME OBSERVATIONS UPON SELECTIVE POWER AS EXERCISED BY CERTAIN SPECIES OF ARENACEOUS FORAMINIFERA.

By Edward Heron-Allen, F.L.S., F.R.M.S.,
and Arthur Earland.

(*Read April 2nd*, 1909.)

Plates 31 to 35.

In the paper which we have the honour to submit to the Club this evening, no attempt is made to *explain* either the processes by which the tests of arenaceous foraminifera are constructed, or the idiosyncrasies displayed by many of the genera and species in the choice of their materials. But the discovery of a species in the construction of whose test the utmost limit hitherto observed, both as regards construction and selection, is reached, has seemed a fitting opportunity to assemble and record some of the facts that present themselves to the student whilst observing these more or less highly specialised organisms.

Before doing so, however, we will introduce the species to which reference has been made.

Sub-Kingdom . . .	Protozoa.
Class	Rhizopoda.
Order	Foraminifera.
Family III. . . .	Astrorhizidae.
Sub-Family II. . . .	Pilulininae.

Technitella, Norman.

Technitella thompsoni,* sp.n.

Test free, sub-cylindrical, rounded and slightly tapering at one extremity and bluntly truncate at the other, consisting of a hollow chamber with composite walls built up entirely of

* I am indebted to my friend Professor D'Arcy Wentworth Thompson, C.B., F.R.S., the Director of the International Committee for Investigation of the North Sea (Scotland), for permission to publish the description of this interesting form, and I have much pleasure in associating his name with it in recognition of the many facilities which he has afforded me in the progress of my work on the "Goldseeker," and in connection therewith.—A. E.

echinoderm plates in a more or less perfect condition. The plates which overlap each other are fastened together without visible cement. No special aperture at either end of the test, the extremities being closed by means of similar plates set at an angle so that they resemble the incurving petals of a flower. Surface of the test neat and regular, and entirely devoid of extraneous matter, but the projecting edges of the flat (or slightly curved) plates used in the construction of the test give a somewhat irregular or serrate appearance to the outline. Hyaline-white in appearance, with slight iridescence when dry, due apparently to diffraction effects caused by the film of chitin with which the separate plates are probably fastened together. Length, 1·8 mm.; breadth at truncate extremity, ·350 mm., widening to ·4 mm., and again diminishing somewhat rapidly to ·250 mm. at the tapering extremity.

This curious little organism was first observed by Earland in 1907, when examining material dredged by the Scottish Fisheries Board's cruiser "Goldseeker," which is engaged in the research work of the International North Sea Commission. The dredging, which was taken at Station 8, Moray Firth (57° 55′ N. 3° 20′ W.) in 33 fathoms (= 60 metres), consisted of a fine muddy sand such as covers large areas in the Moray Firth. Only a single specimen was observed, although a considerable quantity of material was cleaned and examined. This specimen was at first passed by the observer as being merely a fragment of an *Ophiocoma*, such remains being of frequent occurrence in the material. A certain irregularity in the arrangement of the plates, however, led to its examination under a higher-power objective, when the composite nature of the test became apparent.

The specimen was subsequently submitted [as *Technitella legumen* (Norman)] to Mr. Joseph Wright, F.G.S., of Belfast, pre-eminent among the authorities on the British rhizopoda, who stated that, in his opinion, it was "not *Technitella legumen*, and probably not a foram at all." There being no ready means of deciding the rhizopodal nature of the organism without risking its destruction, the specimen was set aside in the hope that others would be found. For more than a year no other was observed, although a very large quantity of material from adjacent stations was examined. Patience was at last rewarded by the discovery of a similar specimen in a dredging taken by the "Goldseeker" at Station 41 C in the North Sea (56° 35′ N., 0° 10′ W., depth 73 metres = 39·71 fathoms). The bottom at

this Station differs considerably from Station 8, Moray Firth, being a tenacious grey mud, but the specimen agreed exactly in construction with the one first found, except that it was a little larger. The plates of which it was constructed were also different from those of the Moray Firth specimen, due no doubt to a difference in the local Ophiurid fauna.

This specimen was mounted in balsam, and gave unmistakable proof of the rhizopodal nature of the organism, the interior being more than half filled with protoplasm of a brownish orange colour in which were a number of darker particles, probably digestion products. As the specimen had been a long time dry, the protoplasm could not be subjected to any reagents.

A careful drawing from the balsam mount was made by Mr. S. C. Akehurst, a copy of which has been reproduced in Plate 31, and is the more valuable to the discoverer of the species as the specimen has since, unfortunately for him, been lost. Prior to this regrettable incident, however, many members of the Club had an opportunity of examining the object, as it was exhibited at two meetings, at the conclusion of the second of which it had disappeared. The Moray Firth specimen, from which the excellent drawing reproduced in Plate 32, was made by Mr. Akehurst, will be placed in the Museum of the University at Dundee.

No further specimens have as yet been found, which is not surprising in view of the rarity of all Technitellae; but no doubt, sooner or later, they will be met with.

Technitella thompsoni differs from all the other species of the genus in the absence of a definite oral aperture, but, owing to the material used in the construction of the test, such a feature would be superfluous, as the pseudopodia find a means of exit already provided by the perforations normally present in the calcareous plates of the Echinoderms. So far as access to the surrounding medium is concerned, the animal is as well situated as if it were one of the perforate forams.

The nearest ally of our specimens, so far as shape is concerned, would appear to be *Technitella raphanus* (Brady), which is known from two specimens only, dredged by the "Challenger" at Station 174, off Kandavu, Fiji, 210 fathoms; but Brady's figures do not show any of that neatness of construction which is typical of the genus, and which is admirably expressed in its generic name (= *little workman*).

Of all the arenaceous foraminifera, *Technitella* is the neatest

builder, and displays the highest development of selective power in the choice of its material. There is, however, a considerable range of skill shown, even among the few species (so called—for specific value is a matter of speculation—or convenience—in the foraminifera) of this genus, and *Technitella thompsoni* must unquestionably take first rank for selective power and neatness of construction. *Technitella melo* (Norman), which favours sponge spicules as building material, is equally skilful at the work of selecting them from the ooze, and builds a neat flask-shaped test, but it employs a considerable amount of ferruginous cement in building the spicules together. Lower still in the scale comes *Technitella legumen* (Norman), which felts minute sponge spicules and mud together, and builds a pretty and thin-walled flask; while at the bottom of the scale comes *Technitella raphanus* (Brady), which, according to the "Challenger" figures, is somewhat roughly constructed.

As illustrating the skill of *Technitella thompsoni* and the great selective power exhibited by the animal, it may be stated that in neither of the dredgings in which it has been found do echinoderm plates, such as are used in its construction, abound. They occur in considerable numbers, as always is the case in shallow-water dredgings, but they form an infinitesimal percentage of the material as dredged, and their presence would be almost unobserved unless especially searched for.

We have stated that, in the species above recorded, the power of selection has reached its highest development, as at present observed. It remains for us to note some of the stages by which that development is reached.

The selective power shown by the arenaceous foraminifera is one of the most striking features of the group. A good deal has been written on the subject, but so far as we know, no explanation has been, or is likely to be found. The solution possibly lies hidden in the debatable domain of bio-chemistry, and many of the remarkable experiments of Bütschli with "foams" point in this direction. Meanwhile, it will not be inappropriate to set forth, in connection with the highly specialised test that we have been considering, some of the more prominent examples, and to speculate on the advantages derived by the organism from its selective powers, and which have led to their evolution or development.

Properly to appreciate the significance of such a marvel of construction as is presented by the shell of any arenaceous

foraminifer, and especially by that of a *Technitella*, one must remember that the animal by which it was constructed was but a tiny particle of protoplasm with a nucleus, having no organs of any kind, whether alimentary, muscular, or nervous. Notwithstanding this, there is a tolerably complete series, ranging between (1) species in which the particles of building material are simply piled together, without much order or definite arrangement, through (2) other species, in which the separate particles of building material are visible, but in which the joints are neatly filled and "pointed" with cement, to (3) species in which the particles of building material are so small, and the quantity of cement used so large, that the bricks are lost in the mortar, so to speak, and a smooth, homogeneous surface results. The cement used by the arenaceous foraminifera is of two kinds, chitinous and ferruginous. The chitinous cement is usually only visible as a film, on which the particles are cemented, but the ferruginous cement, owing to its colour, is one of the most striking features of the whole group.

Owing to their elementary powers of locomotion, the arenaceous foraminifera are limited in their choice of building material to that which may be found constituting the sea-bottom in the immediate neighbourhood of the spot in which they came into existence, the probability being that they shift their ground but very little during the course of their lives. It might be supposed from this that all species from one locality would present features in common, at any rate as regards "raw material." Such, however, is not the case. Most species have a certain range of construction beyond which they seldom transgress, and they are constant to these characteristics in spite of changed surroundings. Thus, in a single dredging in the North Sea ("Goldseeker" Stn. 9) on a bottom of tenacious sand and ooze teeming with life of all kinds, and in which foraminifera especially abound, may be found species which illustrate all the various steps in the ladder of selective power, each taking from the constituent ground-mass just those materials most suited to the construction of its particular test. Thus, *Astrorhiza limicola* (Sandahl) takes material just as it comes, shell fragments, sand-grains, or other foraminifera, and wattles them together with mud into its characteristic roughly built test, which, when completed, is so friable that it is seldom found perfect in dried gatherings, though on cold sea-floors it is by no means uncommon. *Astrorhiza arenaria* (Norman), on the

other hand, chooses fine sand-grains only, of practically uniform size, to build its thick but crumbling wall, in which the sand-grains are held together with a minimum allowance of cement. *Psammosphaera fusca* (Schulze) takes sand-grains or other foraminifera without discrimination as to size, and builds a test which no doubt starts with the intention of being spherical, but owing to the irregularity in the size of its constituent fragments, is more often polygonal, or entirely amorphous. It is one of the commonest of the North Sea foraminifera, and, as a builder, probably ranks lowest in the scale. *Saccammina sphaerica* (M. Sars), on the other hand, using large sand-grains, manages to build a neatly spherical test, often reaching in the North Sea to a diameter of $\frac{1}{8}$ inch, any irregularities in the shape of the grains being dexterously concealed by turning the irregular surface towards the interior of the sphere, which is as rough as the exterior is neat. *Crithionina pisum* (Goës), building a spherical test of about the same size, with no distinctive aperture, rejects all sand-grains, and builds a thick wall with the finest mud only. *Technitella legumen* (Norman), using the same fine mud, felts together a mass of small sponge spicules, and builds a thin-walled flask. Now it is evident that a wall of corresponding thickness, built of mud only, would possess hardly any strength, and it is not unreasonable to suppose that *Technitella* or its ancestors have found out the advantage to be derived from a judicious mixture of mud and spicules. *Technitella melo* (Norman), of which rare form the same dredging furnished a single specimen, discards mud entirely and cements the sponge spicules together, side by side, with ferruginous cement, exercising great ingenuity in the selection of spicules, or fragments of such, of the correct length for the position required.

The list might be largely extended, but sufficient has been said to show that the character of the test and the method of its construction are more or less fixed properties inherent in the animal, and that there is as wide a range of "skill" displayed by the foraminifera both in choice of material and in actual construction, as by builders in the higher scales of life, not even excepting man.

Sponge spicules, which abound to a greater or less extent in most deep-sea dredgings, are largely made use of by the arenaceous foraminifera in the construction of their tests, and they are used in an interesting variety of different ways, of which the principal are as follows:

(1) As building material pure and simple: entire or broken spicules being worked into the wall of the test, apparently without any intentional plan or design. Such examples may be found in nearly all genera with composite tests wherever sponge spicules form any appreciable proportion of the deposit.

(2) To increase the strength of the test: spicules being utilised either (*a*) as "joists" to strengthen the construction of a test, or (*b*) as "laths" in a plaster wall, to retain the layer of mud in position, and to strengthen and support it. As an instance of (*a*) we may quote *Sorosphaera confusa* (Brady), which, in the specimens dredged at "Goldseeker" Station 9, has built its inflated chambers round large tetractinellid sponge spicules which project irregularly from the outside and traverse the chambers. Curiously enough the surface of the sponge spicules within the chambers is covered with a thin layer of the ferruginous cement used in the construction of the test. The object of this is not clear, but presuming this layer to be one and continuous with the lining of the test, it would serve to increase the strength of the joist, as compared with a joist which was merely attached to the wall at the points of entry and exit. As an instance of (*b*) the case of *Technitella legumen* (Norman) already referred to may be quoted.

(3) As building material in preference to any other. Those foraminifera which exercise marked discrimination in the selection of building material usually select sponge spicules in preference to any other material. *Technitella melo* (Norman) and *Marsipella cylindrica* (Brady) afford perhaps the best instances. The material has its disadvantages as well as its merits, for the adhesion of the cement to the glassy surface of the spicule is but slight, and where the spicules are cemented together so that their ends come into a more or less direct line of joints, the risk of fracture is greatly increased. There is a variety of the common Annelid, *Amphictene auricoma* (*Pectinaria*), figured and described by Dr. McIntosh,* which utilises fragments of sponge spicules for its conical tube instead of the usual sand-grains, and we have specimens from the North Sea in which the fragments are built together with a real *bond*, like bricks in a wall. Probably no foraminifera ever attained to such skill in building as this, but *Marsipella cylindrica* (Norman) at its best is nearly

* "On certain Homes or Tubes formed by Annelids," W. C. McIntosh, M.D., F.R.S., *Ann. Mag. Nat. Hist.* ser. 6. vol. xiii. January, 1894.

as clever. Our specimens from the Faroe Channel show a marked tendency to vary the length of the spicular fragments in contiguous lines, and in one specimen the spicules are "laid" with a spiral twist like the strands of a rope. Such an arrangement must be the result of design, and not of mere chance.

(4) As a protection against enemies. There are certain instances in which sponge spicules are employed by foraminifera where their presence seems inexplicable, unless they are employed for defensive purposes. Perhaps the best example is the curious *Haliphysema tumanowiczii* (Bowerbank), long regarded as a sponge. This little organism grows in colonies on algae and zoophytes, where it would be constantly exposed to the ravages of mollusca browsing about. Each specimen completes its test by the addition of a compact brush of sponge spicules which radiate in all directions from the last chamber, and must form an efficient *chevaux de frise* against prowling enemies. *Polytrema*, one of the large perforate foraminifera which grows attached in similar surroundings, has acquired the same habit.

Defence is probably also the explanation in the case of the extraordinary variety of *Crithionina pisum* (Goës), figured by Flint under the name of *hispida*. Here the normally smooth sphere of *C. pisum*, with its thick mud walls, becomes a mass of sharp radiating points, due to the selection of long sponge spicules, which are built into the wall so that they project in all directions. Specimens of *C. pisum* and other foraminifera with a small round hole in the side showing where some predatory mollusc or other animal has broken through and devoured the sarcode body are of frequent occurrence, but such a defensive armour of spines would be an efficient protection, besides perhaps acting as a raft or support to prevent the shell sinking in the soft mud surface of the sea-bottom.

There remains one method of employment of sponge spicules which, if it can be the result of design, is rather puzzling. We refer to the cases where a single sponge spicule is found transfixing an arenaceous foraminifer (compare the figure of *Psammosphaera fusca* (Schulze), in Brady's Report on the Foraminifera of the "Challenger" Expedition, Pl. XVIII., Fig. 4). The spicule *may* owe its position entirely to chance; but it is quite as likely, in view of the rarity of such specimens, that it was designedly built into position. Such projections would be of service to the animal by increasing the area of resistance and by acting as a raft or spar, and so helping to keep the organism

from sinking through the surface layer of ooze in which its food lies, into the dead mud beneath.

Probably we should be considered as imposing too weighty a postulate upon the members of the Club if we ventured to suggest that these rudimentary organisms were gifted with any aesthetic sense. We therefore content ourselves with placing it on record, without further comment, that *Reophax scorpiurus* (Montfort), one of the most variable and cosmopolitan species, shows at times a marked tendency to favour brightly coloured or bizarre fragments in the construction of its test. Garnets are especially favoured by the Moray Firth specimens, but we have also one specimen which has gone out of its way to annex a vertebra from a carboniferous fish. The same partiality for garnets is noticeable in *Verneuilina polystropha* (Reuss) at several stations in the Moray Firth, and we have observed the phenomenon also in specimens collected at one particular station off Selsey Bill in Sussex, where *Verneuilina* and *Haplophragmium* work up, not only garnets and magnetite, into their tests, but also a rhomboidal gem-mineral (?), the precise nature of which is at present engaging our attention.

To recapitulate these prolegomena towards the study of structural design (in both its senses, intention and result), it would appear that this "primordial, protoplasmic, atomic globule" is by no means so elementary an organism as naturalists are inclined to believe. The study of the laws upon which are based the principles of that "selection" which forms the subject of this paper goes hand in hand with that of the reproductive functions of the foraminifera. Earland has published some of the results of his observations upon the latter subject in the Journal of this Club.* It is probably reserved for some careful observer endowed with great wealth of time and opportunity to make so minute a study of the living foraminifera as to arrive at a revelation of the processes by which these higher functions of the Order are governed and exercised.

Description of Plates.

Plate 31.

Technitella thompsoni, sp.n.

After a pen-and-ink drawing of the lost specimen from Station 41 C made by Mr. Akehurst. Viewed as a transparent object in balsam. The protoplasmic body is visible as an irregular dark

* *Journ. Quekett Microscopical Club*, Ser. 2, Vol. IX. No. 57, November, 1905: "The Foraminifera of the Shore Sand at Bognor, Sussex."

patch extending down the middle of the shell. Magnification about 75 diameters.

PLATE 32.

Technitella thompsoni, sp.n.

The Moray Firth specimen viewed as an opaque object. Drawn by Mr. S. C. Akehurst. Magnification about 75 diameters.

PLATE 33.

1. *Astrorhiza limicola*, Sandahl. × 6.
2. „ *arenaria*, Norman. × 9.
3. *Psammosphaera fusca*, Schulze, composed of sand grains. × 11.
4. *P. fusca*, Schulze, composed of tests of foraminifera. × 11.

PLATE 34.

5. *Saccammina sphaerica*, M. Sars. Group of 7 specimens. × 6.

5*a*. Two specimens from same group photographed to show internal roughness.

6. *Crithionina pisum*, Goës. × 20.

6*a*. Specimen of same laid open to show thickness of shell-wall.

7. *Crithionina pisum*, Goës, var. *hispida*, Flint. × 20.
8. *Technitella thompsoni*, sp. n. The Moray Firth specimen. × 17.
9. „ *melo*, Norman. × 27.
10. „ *legumen*, Norman. A broken specimen, showing at the fractured extremity the outer layer of sponge spicules embedded parallel to the long axis of shell. × 24.

PLATE 35.

11. *Marsipella cylindrica*, Brady. Showing sponge spicules laid with a spiral twist. × 26.
12. *Haliphysema tumanowiczii*, Bowerbank. A colony of individuals attached to a Zoophyte. × 10.
13. *Psammosphaera fusca*, Schulze, variety. × 38.
14. Portion of tube of an Annelid, *Amphictene auricoma* (Pectinaria). Spicules arranged in "bonded" layers.

NOTE.—Since the above paper was written an interesting fact concerning *Technitella legumen* has been brought to light by the accidental breaking of a specimen. The shell is built up of two distinct layers. In the outer layer the spicules are embedded in the mud so that they lie parallel to the long axis of the test (Plate 34, Fig. 10). In the inner layer, however, the spicular fragments are much shorter, and are laid at right angles to the outer layer, *i.e.* across the wall. This admirable arrangement obviously gives a resistance to strain in two different directions.—A. E.

The figures in Plates 33, 34, 35, are reproduced from direct photographs of the original specimens taken by Mr. A. E. Smith.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on October 2nd, 1908, Professor E. A. Minchin, M.A., President, in the Chair, the minutes of the meeting held on June 19th were read and confirmed.

Messrs. William Richards, Edward Arthur Blockley, and Edward Britton were balloted for, and duly elected members of the Club.

A number of donations of books and periodicals were announced, and the thanks of the Club voted to the donors.

The President announced that in future the "Gossip Nights" of the Club would be held in the North Room on the third Friday in the month.

The Hon. Secretary referred to the loss the Club had sustained in the death at Folkestone, on August 11th last, of Mr. F. H. Wenham, one of the oldest of the Club's honorary members. Although Mr. Wenham was primarily an engineer, and was the first to introduce the use of high-pressure steam in marine engines, turning his attention also to gas engines and to the use of superheated steam, it was his many and useful inventions in microscopical and allied instruments with which members were immediately interested. The Wenham binocular prism, suitable for the lower powers of the microscope, was universally known. The single-front and the oil-immersion objective were both due to the genius of their late member.

The Hon. Secretary was requested to convey an expression of the members' condolences to the relatives of the late Mr. Wenham.

Mr. T. A. O'Donohoe exhibited and described some photo-micrographs × 2000 of the Podura scale. He said it was usual

to photograph this object with a very small condenser cone. If this is done we get a constricted head with a very fine line extending about two-thirds down the "exclamation mark." A photograph showed the effect of a very small cone (0·35) giving an image with a head resembling a pin-head. After taking another photograph (exhibited), with aperture 0·65, he found that the focus had not altered in the least, and cut down the condenser to 0 45 to observe the effect produced. This gave the constricted head and fine line. He was convinced that photographs with a very small cone gave an altogether wrong impression. Mr. O'Donohoe made some further remarks on some fine transverse markings which he had not seen before, but which had been noted by Mr. Nelson.

Mr. C. F. Rousselet, F.R.M.S., read a note on the "Rotatorian Fauna of Boston, U.S.A.," with a description of *Notholca bostoniensis*, sp. nov. The author, who attended the seventh International Zoological Congress in August, 1907, at Boston, U.S.A., as delegate of the Quekett Club, examined the lakes and ponds in the vicinity of the city. Examination of the material collected has shown the presence of forty different species of free-swimming Rotifera, one of which, *N. bostoniensis*, is new to science, and another, a free-swimming *Oecistes* (sp. ?), probably also new, and several rare and interesting species which have been met with only once before. The new species has considerable resemblance to *N. longispina*, Kellicott—a well-known and widely distributed species; but close examination shows important differences in the structure of the lorica. Preparations of the new species and of several other forms were exhibited under microscopes.

Mr. D. J. Scourfield, F.Z.S., F.R.M.S., made some remarks on the Entomostraca Mr. Rousselet had brought from Boston, some preparations being then exhibited, and mentioned that all forms of *Diaptomus* from U.S.A. were different from the European forms.

Mr. T. B. Rosseter, F.R.M.S., read a paper on the family Taeniidae. He said his first intention had been to give to the meeting an account of his work on *Hymenolepis farciminalis*,

but their secretary had suggested that a sketch of the family Taeniidae, and more especially of the genus *Hymenolepis* (Weinland), on which the speaker had for some years past concentrated his work, would probably be of greater general interest. Until the time of the Danish naturalist and helminthologist Krabbe, of Copenhagen, very few naturalists had made the life-history and anatomy of avian tapeworms their particular study. It was Krabbe who unravelled the tangled skein by gathering together and differentiating the various species of avian tapeworms enumerated and described since the days of Bloch, Pallas, Goeze, and others in the latter part of the eighteenth century, and Rudolphi, Cobbold, Pfaff, Berg, and others of later years who had made, or were making, special study of avian entozoons. In 1869 Krabbe published a description of 123 species, with 313 figures, and in 1882 a second part, dealing with an additional 42 species, with 67 figures. Both these works are in Danish, and have not yet been translated. Krabbe confined his attention to the armed tapeworms of birds, and his drawings and measurements of the various species are so accurate that the student in helminthology who has Krabbe's *Bidrag* cannot fail to discriminate and determine the species of *Taenia* he has under consideration, of which he might be in doubt. Up to the time of Krabbe and Weinland, tapeworms, with but one or two exceptions, whether they were the guests of mammals, fishes, reptiles, or birds, were classed as *Taeniae*; the genus *Taenia* was, in fact, the "kitchen-midden" for the whole group. The first to emphasise the necessity for the determination of species otherwise than by the armature was Mequin, who, in 1880, said that "every hookless *Taenia* has its armed species, and becomes hookless by caducity, and devoid of a scolex by resorption." Thus hookless or inerme tapeworms, according to Mequin, do not exist. He also, in conjunction with Moniez, asserted that there was a continuous development without change of host. Thus they were opposed *pari gradu* to Steenstrup's "Law of Alternation of Generations." A translation into English of Steenstrup's work was published by the Ray Society in 1845. At the time Steenstrup formulated his law but little was known

of the life-history of tapeworms in general, yet we now know experimentally that the law is not only applicable to, but is perhaps most forcibly illustrated in, the development of the Cestoidae. The itinerary is as follows: Primarily, a six-hooked embryo; second, the cysticercus; third, the scolex; fourth, strobila; and, lastly, the sexual animal with the uterine proglottis. These stages may be reduced to three: the six-hooked brood, cysticercus, and mature worm. The author then gave a short account of the work done by various investigators, since von Linstow (1872), who, seeking and finding cysticercoids in fresh-water copepods, cypridae, annelidae, and insecta, and comparing the hooks of the embryonic scolex with those given by Krabbe for the mature worm, have endeavoured to establish their identity. Mr. Rosseter said that credit is due to Dr. Stiles, of Washington, who, in 1896, published his *Tapeworms of Poultry*, for plainly stating that the comparison of the hooks upon the heads of adult tapeworms in birds with the hooks of larvae found in invertebrate bodies did not explain the life-history, nor furnish the data which the science of the day demanded, and that experimental infection with these supposed larvae, and the production of the mature worm, was what was required. After referring to the successful experiments of Grassi and Rovelli in 1888–92, the speaker gave some particulars of his own work in this direction. In 1891 he fed some ducks with a characteristic larval tapeworm he found making *Cypris cinerea* its host, and on killing the ducks, found them to be infested with a tapeworm whose scolex bore the same characteristic hooks as the cysticercoid. This was submitted to R. Blanchard, of Paris, who formed a new genus and species for it. Reference was also made by Mr. Rosseter that at the time of the appearance of Stiles's work he had already infected ducks with *Taenia cornula*, *T. gracilis*, and *T. tenuirostris*, and in each instance produced the specific tapeworm. The speaker then stated that while certain workers preferred the study of the cysticercoid form, other helminthologists, including himself, had turned their attention to the internal anatomy of avian tapeworms, and for the following reasons. Primarily, the species

are so numerous, and the length of the strobila so variable, ranging from Rudolphi's *T. longiceps*, ·3 mm. to ·4 mm. long, to one of Pfaff's new species taken from *Anas glacialis*, 420 mm. long; secondly, great difficulty is experienced in procuring the scolex and hooks, even in young forms, owing to the attenuation of the neck, causing the scolex, when the tract is emptied, to be broken off and left behind in the mucous membrane or mixed with the faeces; and, lastly, difficulties arise due to the occurrence of aberrant and abnormal forms, such being probably caused by cross-fertilisation. Passing on, the speaker proceeded to consider and describe at some length the suggestions of Weinland of Cambridge, U.S.A., in 1858, for the dismemberment of the Linnean genus *Taenia*, and the establishment of the genera *Diplicanthus* and *Hymenolepis*. The difficulties raised, and objections put forward, against the formulae of Weinland, and an account of recent work on the genus *Hymenolepis* followed, and reference was made to the establishment by Railliet of Paris of the new genus *Drepanidotaenia*. Mr. Rosseter then proceeded to describe his methods of investigation. He said that to empty the alimentary tract it is first uncoiled and the appendages detached. The rectum is slit up and excised, the contents being examined. Then, beginning close up to the gizzard, the intestine is taken between thumb and finger, and by downward pressure the contents emptied into a flat porcelain pan containing tap-water. Whatever worms are visible, either to the naked eye or with a watchmaker's glass, are picked up with hooked needles, and placed in watchglasses containing an aqueous solution of glycerine. They may then be examined with a 2-in. objective. To mount unprepared specimens in glycerine, they are passed through different grades, and finally mounted in pure glycerine. A cell is made with Bell's cement; when partially dry the quantity of pure glycerine required is placed in the centre and the specimen immersed. After leaving it for a short time it is arranged and covered with the cover-glass, letting the glycerine flow to the edges. The cover is held in position by brass clips, and the superfluous fluid mopped up. Bell's cement is run round the cover and left for, say, 24 hours. It is again

mopped over, and is finished by enclosing with gold-size. This method has been found quite satisfactory. Particulars were also given of the methods employed when it was required to prepare specimens for dissection, staining, or section-cutting.

At the meeting of the Club held on November 6th, 1908, Professor Minchin, M.A., President, in the Chair, the minutes of the meeting held on October 2nd were read and confirmed.

Messrs. Albert H. Quick, William M. Sharp, A. H. John, Max Rink, J. M. Broad, and F. R. Winn-Sampson were balloted for, and duly elected members of the Club.

Donations of books were announced, and the thanks of the Club voted to the donors.

The President referred, with regret, to the death, on October 11th, of Mr. W. Saville Kent, F.L.S., F.Z.S., etc. He supposed that most members were acquainted with Mr. Kent's *Manual of Infusoria*, a three-volume work of extreme value and usefulness. Reference was also made to Mr. Kent's work on corals, and his important book, *The Great Barrier Reef of Australia*. The very complete collection of Australian Madreporaria at the Natural History Museum, South Kensington, was formed by him while engaged as fishery inspector to several of the Australian Colonies.

The President exhibited a number of preparations of blood parasites—Trypanosomes and Trypanoplasms—of fresh-water fish from the Norfolk Broads. In the course of his remarks describing these, he said these organisms were first observed in 1841, and were named in 1843. Latterly, much attention had been given to them, especially in regard to sleeping-sickness. Many, but certainly not all, trypanosomes were lethal. The group was entirely confined to the vertebrates. Nearly every known species of vertebrate was the host of a trypanosome, but very many were quite harmless—for example, those found in the blood of the London sewer-rat, and others noticed in various fish, such as bream, pike, tench, eels, etc., taken in the Norfolk Broads. Two distinct genera are recognised—*Trypanosoma* and *Trypanoplasma*. Of these, the first-named has but one flagellum, and the second may

be distinguished by the possession of two flagella and a much larger nucleus than is found in species of *Trypanosoma.* The genus *Trypanosoma* is parasitic in all classes of vertebrates, but *Trypanoplasma* is only found in fishes. In fresh-water fish, however, both genera may be found parasitic together. In fact, this is more usual than to find only one type. The easiest method of obtaining specimens is to take a common eel alive, and kill it by a blow on the head with a blunt instrument. Take a drop of blood from the heart as quickly as possible, as the blood of fish coagulates much more rapidly than is the case with mammals, and put under cover-slip. The blood dries round the edges, and so seals up the enclosed film. In the case of a Norfolk Broad eel, well infected, after 24 hours specimens prepared as just described were still active, at 48 hours slower, and at 72 hours nearly moribund. If, after putting on cover-slip, the preparation is at once sealed with vaseline, these organisms have such extraordinary vitality that they will live and even divide. The President had had some alive for nine days in this condition. An extensive range of size and structure had been noted in *Trypanosoma* in fish, and particularly in the eel, where all stages are found. In the pike, two sizes only, large and small, are common; in the perch three forms are found. *Trypanoplasma* also shows dimorphism. It has been suggested that the large and small forms may possibly correspond to male and female, and the intermediate the form from which male and female develop. It was mentioned that there were many problems still unsolved relating to the life-history of these protozoa. The current idea as to the method of infection of fish was that the trypanosomes were carried by leeches. Unfortunately, there was no monograph or general handbook to British leeches of later date than 1846, so that there was great difficulty in identifying species. He would suggest that some member or members of the Club take this matter up. Concluding his remarks, the President said that his investigations had been made during the last two summers at the Sutton Broad laboratory, a private laboratory owned by Messrs. Eustace and Robert Gurney. It was near Catfield, and was a most delight-

ful place, with many rare birds and swarms of vipers (!) in the garden.

Replying to a question by Dr. Spitta, the President said all the pathogenic species of *Trypanosoma* were much smaller and very distinct in structure, and all the evidence tended to show that the forms found in fish would not live in the blood of mammals. These parasites, especially the harmless forms, are quite specific to the host. The trypanosome of the rat died at once if transferred to the mouse, and even in the guinea-pig it would only live a little while, and would not multiply. Lethal forms, however, flourish in many different hosts. The study of trypanosomes was of great importance, both zoologically and economically.

On the proposal of Mr. D. Bryce, seconded by Mr. F. P. Smith, a very hearty vote of thanks was accorded to the President for his remarks.

Mr. T. A. O'Donohoe read a note, illustrated by a number of excellent lantern slides, on "The Photographic Evolution of the Fine Structure of the Podura Scale." He said, in the *Illustrated Annual of Microscopy* for 1898 there are four photographs of the Podura scale by two of the ablest photomicrographers living, who were well equipped with the very best apochromatic objectives and condensers. It may therefore be fairly assumed that these photographs represent all that was then known of the Podura scale. The one (× 1000) by Dr. Spitta shows a constricted head and white streak to the "exclamation mark," and that is all. The spaces between the "exclamation marks" show no trace whatever of structure. Mr. Gifford's three photographs at × 1350, × 1944, and × 4860 respectively do, here and there, show some fine vertical lines between the marks; but they are so faint that the speaker noticed them only when, some years later, he was comparing these photographs with his own, in one of which (then thrown on the screen), the fine vertical lines emanating from the heads of the "exclamation marks" were well brought out. In 1905, at Mr. Nelson's suggestion, he produced a photograph showing the membrane of the scale, and, later, two others, the second at

× 4000 direct. He then thought that practical finality on this subject had been reached. A few months ago, however, on returning to London after an absence of some five years, the assistant secretary of the Royal Microscopical Society had drawn his attention to the paper on the Podura scale by Mr. Nelson in the *Journal R.M.S.* for 1907. In this paper is described and figured a fine mycelioid structure, and in addition "some minute horizontal filaments of great tenuity joining the vertical lines, the visibility of which by transmitted light requires a fine objective and skilful manipulation." Mr. O'Donohoe said he was at once seized with a strong desire to see, and if possible photograph, this structure. With a condenser cone of N.A. 0·65 he produced a "black-dot" image (photograph shown). This exhibited the fine transverse filaments, which were identical with those shown in the following "white-dot" image, taken with a cone of N.A. 0·85. Mr. Nelson's criticism of the "black-dot" photograph was that it showed the heads of the "exclamation mark" convex and not concave, and that the fine markings between the "exclamation marks" were rather like diatomic perforated structure instead of like fine bars. Mr. Nelson suggested that the image sought for was at a trifle higher focus, and is seen in a blaze of light, with a full cone of N.A. 1·0 from the condenser. The author then used a Watson immersion condenser of N.A. 1·30 cut down to 1·0, and the image sought was at once observed; the fine structure and concave heads were well seen. Efforts to photograph these with aperture N.A. 1·0 proving unsuccessful, a cone of 0·85 was used. This gave the fine lines, but not the concave heads. Further attempts, however, with full cone (N.A. 1·0) at length proved successful, and of the photograph shown Mr. Nelson had written that it was the best photograph of the Podura scale he had seen, and hoped that it would be accepted as the true view of the scale. Mr. O'Donohoe also showed a photomicrograph of Mr. Nelson's "electric-light" image, described *Journal R.M.S.*, 1907, p. 399.

Dr. Spitta could not agree with Mr. O'Donohoe as to the cause of the markings observed. He thought they were probably due to the cusps of the next lower layer. While congratulating the

author on his skill in photomicrography, he thought that the utmost that should be said was that the photographs represented the image as seen at the time.

A paper by Mr. F. P. Smith on "Some British Spiders taken in 1908," was taken as read.

Mr. F. P. Smith delivered a lecture, illustrated with a number of interesting lantern photographs, dealing with "Flies, from Several Points of View." In his introductory remarks, the lecturer said that he had taken "flies" as the subject of his little chat for the following reason. During the last twelve years he had been studying the Arachnida; and in spite of the fact that he had endeavoured in every possible way to minimise the distaste which the average human being possessed for anything in the nature of a spider, so far his efforts seemed fruitless. Personally, he rather blamed the fly for this state of affairs; for whenever the spider is conjured up in the popular mind, it is as the ruthless destroyer of the helpless, harmless flies. He therefore wished to review the flies, not from his own possibly prejudiced standpoint, but from the point of view of others, in order that those present might have an opportunity of judging for themselves whether these insects really merited the sympathy usually meted out to them. The lecturer dealt first with the subject from the point of view of the man at the museum—the individual who recognises 40,000 species of flies, and is sorely tried in his endeavours to formulate for them a satisfactory system of classification. The various characters upon which the order had been subdivided were mentioned, and also the difficulties which arose even in defining what really constituted a "fly." Next came the man with the microscope. To him the fly was a source of delight, furnishing endless objects of great interest and beauty. Photomicrographs of some of the more familiar microscopic objects derived from the Diptera were exhibited in the lantern. The man with the pocket-lens—the intelligent field naturalist—was next considered. To him all nature was wonderful, and flies not the least so. The amount of real study which could be accomplished with a simple magnifier was very great; but in many cases the man with the

pocket-lens did not fully appreciate its powers, and the man who worked with the compound instrument often rather despised the simple one. A series of photographs of extremely common Diptera were shown, very similar in general appearance to the unaided eye, but easily differentiated with a magnification of three or four diameters. Studies of the head of a living blow-fly as seen through a Coddington lens were next exhibited. Mr. Smith said that, although the actual examination of objects under such a lens was so simple a process, the satisfactory reproduction of the same effects with the camera was one of the most difficult branches of nature-photography he had come in contact with. By the man at the farm, flies were generally regarded as harmless nuisances—but altogether by reason of his ignorance, for they are amongst his bitterest enemies. Usually, however, their depredations are apparent when they are in the larval stage, and the farmer does not recognise his foes in the winged form. The Hessian-fly was mentioned, and also the Crane-fly, the parent of the dreaded "leather-jackets." Continuing, the lecturer said that the medical man was now beginning to regard the flies as a curse to humanity. The mosquitoes undoubtedly were responsible for the transmission of malaria and yellow fever; and sleeping-sickness and the dreaded nagana were carried by species of *Glossina* (tsetse-flies). Even "blow-flies" and house-flies were now in bad odour, it being believed that they were responsible for the dissemination of "summer cholera." The "man in the street" regards the fly simply as a nuisance, especially when it crawls over his bald head. He reads awful accusations against it in the papers, but declines to believe them. Feeling rather badly disposed towards flies in general, the lecturer said that he rather enjoyed the final view of the matter—a consideration of those creatures which assisted in the destruction of superabundant flies. Wasps, spiders of many kinds, geckoes, lizards, and tree-frogs were all described and illustrated, and also the microscopic fungus which plays such havoc with flies in the autumn.

Before adjourning the meeting, the President said he had to thank Messrs. Baker for the loan of the microscopes used in

displaying his preparations of blood parasites. The objectives employed were the new $\frac{1}{12}$-in. oil immersion of N.A. 1·30, just issued by that firm. They were made on a new formula, and had a very flat field.

At the meeting of the Club held on December 4th, 1908, Professor E. A. Minchin, M.A., President, in the Chair, the minutes of the meeting held on November 6th were read and confirmed.

Messrs. T. Brooks, T. S. Wilkins, G. Howard, and F. E. Sharp were balloted for and duly elected members of the Club.

Several donations, including a series of back numbers of the *Journal* presented by Mr. W. H. Venables, were announced, and the thanks of the Club voted to the donors.

Mr. F. W. Watson Baker, F.R.M.S. (for Messrs. Watson), described a form of exhibition, or museum, microscope designed by Mr. Waterhouse, of South Kensington. The usual 3 by 1 slips were carried on a drum rotated by a large milled head. A spring catch indicated the centre of each slip. Focusing was provided for by a rotating eyepiece, the whole being enclosed in a glass case, the only projections being the eyepiece and the milled head. It was found necessary in cases like this to build the instrument so that it was not possible to remove any part from the outside. This, he thought, had been successfully accomplished. Two instruments of this design had been employed for the exhibition of specimens by Mr. Rousselet at the Franco-British Exhibition.

A new growing-cell for use with the highest powers, designed by Mr. A. A. C. Eliot Merlin, F.R.M.S., was described by the Hon. Secretary, from a specimen exhibited by Messrs. Baker. A specimen of Dallinger's growing-cell was lent by Messrs. Beck for comparison. This consists of a glass plate on a vulcanite platform. In the centre the object is placed, surrounded by a vulcanite ring, and kept moist by blotting-paper, which dips into a glass tube holding water attached to the base-plate. A rubber cone fits over the object-glass, and is placed in contact

with the cover-slip, thus minimising evaporation. It is not intended for use with immersion systems. Mr. C. Beck had in one instance kept under observation for ten days *Actinophrys*, and was able to watch the entire life-history, getting at the end of the time eleven individuals from the single specimen started with. Mr. Eliot Merlin's form consisted of a real Rousselet live-box with cemented cover-glass, and was, therefore, airtight. It had thin glass below. The thickness of the cell was adjusted by the number of rings of blotting-paper employed, and the water was obtained from two small wells. Provision was made for heating, and a thermometer was attached. It was altogether a very convenient form, and was well adapted for use with immersion objectives, which could be easily changed without at all affecting the object.

The President thought the new cell would be found very useful. It seemed particularly suited for observations requiring the maintenance of a given temperature, as when examining organisms from the blood of warm-blooded animals.

Mr. J. T. Holder intimated that at the "Gossip" meeting to be held on December 18th he would have a number of sections of coats of eyeball of pigeon in celloidin ready for staining, which he would be pleased to give to members interested. A small tube containing 70-per-cent. alcohol should be brought to contain the sections.

The Hon. Secretary (W. B. Stokes) wished to say a few words with regard to some remarks by Mr. O'Donohoe at the last meeting. Mr. O'Donohoe had really been misunderstood. He was really announcing a new discovery, that the "white-dot" image (of diatoms) required a different tube length from that necessary with the "black-dot" image, and that the two images of the Podura scale which he presented corresponded to the "black-dot" and "white-dot" images of diatoms.

Mr. D. J. Scourfield, F.Z.S., F.R.M.S., gave a lecture illustrated with lantern-slides on "The Locomotion of Microscopic Aquatic Organisms." The lecturer proposed to give some brief account of the various methods employed by microscopic aquatic organisms, and of the conditions affecting locomotion under

water. It must be remembered that in such cases the medium in which the organisms are immersed affords them very considerable support, not only for their bodies, as a whole, but for all their appendages and outgrowths, if such be present. This, of course, is due to the fact that the majority of such organisms are, in the main, made up of tissues having a specific gravity very little greater than that of water, and therefore the most delicate and jelly-like creatures can live in water without difficulty. And, as a matter of fact, the most delicate and fragile of all known organisms are found in water. In consequence of this equable support, and the small amount of friction involved, very little energy has to be expended to produce slow movements, and if the organisms are actually of the same specific gravity as water, and can get their nourishment directly from the substances dissolved therein, as sometimes happens, it is not necessary for them to be provided with swimming organs at all. They can then depend entirely for change of position upon the never-ceasing movements, due to various physical causes, taking place in the water itself. As water, compared with dry land, offers such a small amount of resistance, it is at once apparent that for movement at any but the slowest speeds the locomotive organs must either possess very large surfaces, so as to get a grip of the water, or, if small, they must act in a very rapid manner. Numerous instances of both of these arrangements occur among microscopic aquatic organisms. The simplest mode of progression is that found in *Amoeba*, the second is produced by the action of flagella, and, in the third type, by the action of cilia. More specialised modes follow, and include medusoid motion, the method adopted by Nematodes, another method in the case of Salpa, and the highest method of locomotion—that due to appendages actuated by muscles—in more complete forms. A point for consideration in connection with movement under water may be here referred to. It is the difficulty of keeping a straight course owing to the want of a datum line, or even fixed points, for both horizontal and vertical directions, from which bearings may be taken. In submarine vessels some automatic arrangement is

necessary, and in aquatic creatures some similar contrivance is found, the most common, probably, being the power of rotation on the long axis. This rotation produces a compensating effect for any little irregularities in motive power; and although the actual path is really a long spiral, its general direction is practically a straight line. Passing on to deal with the actual methods of locomotion found in the organisms under discussion, the lecturer described at some length the means of progression observed in *Amoeba*. Examples of amoeboid movements are very common among the class to which *Amoeba* belongs—that is, the Rhizopods, and including the Foraminifera. Owing to the observations and experiments of Bütschli, Rhumbler, and others, it is probable that in its main features amoeboid motion is essentially a physical phenomenon, depending chiefly upon changes in the surface-tension of the naked protoplasm of these organisms. It was pointed out that while usually the movements of pseudopodia are very slow, and are ineffective except when in contact with solid bodies, yet in a few forms the pseudopodia are long and fairly vigorous in movement, and may be taken as transition forms between typical pseudopodia and the flagella or whip-like organs next to be considered. A flagellum may be defined as a permanent, motile, whip-like extension of the living protoplasm, capable of moving the whole organism to which it belongs, and capable of independent motion if, as is sometimes the case, it is accompanied by other flagella. Some flagella have been shown to have connection with the nucleus of the cell; but this is exceptional. It is considered that the motive-power of a flagellum resides in the flagellum itself. Mr. Scourfield then proceeded to deal with the difficult question as to how a single whip-like organ produces motion in a straight line of the organism to which it belongs. The only reasonable explanation seemed to be that a succession of waves are set up, travelling backwards along the filament. These waves are not confined to one plane, but rotate as they progress, thus throwing the flagellum into a spiral form—the effect produced being, in fact, similar to that in a rotating corkscrew, with the essential difference that the

flagellum does not rotate; and the mechanical problem thus involved is one by no means easy to solve. In the case of collared monads the motion observed is the reverse of that usually found in flagellate organisms. The rotation is probably in a left-handed spiral, as against the usual right-handed motion. Flagella of Bacteria had been mentioned; but it was suggested that the term in this case was not well applied. Passing on to consider locomotion caused by the action of cilia, these may be defined, like flagella, as permanent, whip-like extensions of the living cell-substance, but, unlike flagella, are incapable of moving by individual effort the body to which they are attached (being usually small in comparison with the body). Cilia are always associated in number, and act in harmony. In the case of cilia, we are dealing not with spiral motion, but with whip-like action in one direction, and with motion very much more rapid in one plane than the other. A slight retardation in the moment of lashing of successive cilia or rows of cilia produces the well-known illusion observed, *e.g.*, in the ciliary organs of Rotifers, giving an appearance like rotating cogwheels, and in other cases as of waves travelling over a field of corn. References were made to instances of specialised cilia, as, for instance, when a *Vorticella* becomes detached it swims away by the action of the mouth cilia. The presence of cilia for locomotive purposes extends to many very different types of organisms. The highest developments of these appendages are found in the ciliated Infusorians; but cilia also occur either permanently, or in certain stages only of the life-history, in Sponges, Hydrozoa, Echinoderms, Worms, Rotifers, Gastrotricha, and Mollusca, and perhaps *Volvox* may also be included, as it is extremely doubtful whether the individual threads in this last instance act in the spiral manner characteristic of flagella; but this particular instance has not yet been fully worked out. Other methods of progression were then referred to. There is what may be called medusoid motion, which consists of the sudden contraction of the sides of a more or less umbrella-shaped organism. This type of motion is well shown among microscopic forms by the curious protozoan *Leptodiscus* occurring in

the Mediterranean, and by the medusoids of certain Hydrozoa. In the case of Nematodes and many insect larvae, locomotion is obtained by throwing the body into a series of waves or even figures-of-eight. Another type is Salpa, where water is taken into the body and suddenly ejected. Such a method has been used for the propulsion of small vessels. In more advanced organisms we find spines worked by muscles, which almost correspond to limbs, and by the sudden movement of which the organisms can dart about in a very rapid way. Forms such as these, in this respect at least, serve to bridge over the gap between the Worms and Arthropods. It is amongst the little crustaceans known as Entomostraca that we must look for the highest development of swimming appendages among microscopic aquatic organisms. The most primitive of these, the Phyllopods, possess very many pairs of foliaceous feet, of elaborate and beautiful construction, which beat the water rhythmically. In the related order Cladocera the swimming movements are brought about by a special adaptation of the second pair of antennae. The direction of the stroke, at least in the genera *Daphnia* and *Simocephalus*, has been found to be slightly oblique to the axis of the body, having a slight inclination towards the back—a circumstance which gives rise to a tendency for the locomotion to take place in a curved path. This, however, is counteracted partly by the action of gravity on the body between the strokes, and also probably by the resistance offered to the turning movement by the long shell-spines which most of the more rapid swimmers possess. But it is among the Copepods that we find the most noticeable swimming organs. The four or five pairs of feet are usually broad, two-branched, paddle-like organs, provided with fringing hairs and feathered spines. The tail, also, has a set of feathered setae, and probably assists in movement. In the case of *Cyclops*, the antennae do beat; but it is not certain that they assist in locomotion, being probably chiefly balancing organs. It will be noted that in certain forms we may find one individual possessing four different methods of locomotion—the antennae, the mouth-organs, the feet, and the tail. In

concluding his remarks, Mr. Scourfield referred to the vexed question of the motion of diatoms, and, among other points, hoped that the cinematograph would be employed in the recording of these different methods of locomotion. The lecture was illustrated by a number of diagrams and photographs of the forms referred to, and by several autochrome photomicrographs of water-mites lent by Mr. Taverner, F.R.M.S.

The President said the most active amoeboid movements were exhibited by certain cells—star-shaped, and with long, slender processes—found in the body-cavity of the sea-urchin. There was also found a lumpy form, best described, perhaps, as "potato-shaped." These had a red coloration, and were very interesting to watch. The relation between pseudopodia and flagella was very difficult to decide. Many primitive forms began life with flagella, and subsequently lost them and developed pseudopodia.

Mr. F. P. Smith (Hon. Editor) would strongly recommend the use of the cinematograph in this connection. It was, however, unfortunate that Entomostraca, for instance, objected strongly to the enormous actinic power of the illuminant which the speaker had found it necessary to employ.

FORTY-THIRD ANNUAL REPORT.

However accentuated may have been the difficulties that beset scientific societies, your Committee is convinced that the Club has maintained its useful and honourable position during the past twelve months.

The number of members elected during 1908 was thirty-eight. This number is ten less than in 1907, but not greatly below the average for the period 1898–1907, which was 43·4. There have been no special demonstrations to attract new members, and the year has been the worst in trade and finance that has been experienced for a long time. By resignations we lose eighteen and by death four members, leaving a net gain of sixteen. The number of members on the books on December 31st, 1908, was 446.

The average attendance at ordinary meetings in 1908 was 95·9, as against 101·7 for 1907. The best attended meeting was on November 6th, when 113 were present.

The number of papers brought before the Club is disappointing. Why 1908 should be less fertile in original contributions your Committee is unable to say; but, while recognising the impossibility of forcing the pace, it is hoped that members will try to secure for the Club such results of real original work as are available. The following papers were published:—

Jan.	*Hymenolepis fragilis* . . .	Mr. T. B. Rosseter.
,,	The Male Genitalia of the Cockroach, etc.	Mr. W. Wesché.
Feb.	President's Address. The Photography of very Translucent Diatoms	Dr. E. J. Spitta.

March.	The Causes of Reversing Currents in the Plasmodia of Mycetozoa	Mr. A. E. Hilton.
,,	The genus *Hydrachna* . .	Mr. C. D. Soar.
June.	The Proboscis of the Blowfly .	Mr. W. Wesché.
Oct.	*Notholca Bostoniensis*, etc. . .	Mr. C. F. Rousselet.
,,	*Hymenolepis farciminalis* . .	Mr. T. B. Rosseter.
Nov.	British Spiders taken in 1908 .	Mr. F. P. Smith.

The following lectures and exhibitions were given:—

Jan.	Various Photomicrographs .	Mr. C. Lees Curties.
,,	Projection of Polariscopic Effects	Mr. Large.
May.	Various Rare Insects . .	Mr. R. T. Lewis.
,,	Calcareous Sponge Spicules .	Prof. E. A. Minchin.
,,	The Romance of Insect Life .	Mr. F. Martin-Duncan.
Nov.	Blood Parasites of Fishes .	Prof. E. A. Minchin.
,,	Flies, from several points of view	Mr. F. P. Smith.
,,	Photomicrographs of Podura Scale	Mr. T. O'Donohoe.
Dec.	Locomotion of Microscopic Aquatic Organisms . .	Mr. D. J. Scourfield.

Your Committee desires to thank the authors of these papers, lectures, and exhibitions.

Members are reminded that new or revived appliances are always of interest. Among such as appeared during last year may be noted:

Feb.	Improved Drawing Mirror . .	Mr. W. Imboden.
,,	Improved Immersion Paraboloid .	Messrs. R. & J. Beck.
,,	Inexpensive Side-Reflector . .	Mr. W. B. Stokes.
May.	Improved "Cheshire" Apertometer	Mr. C. Baker.

May.	Barnard's Mercury Vapour Lamp	Mr. C. Baker.
Nov.	New Formula $\frac{1}{12}$-inch N.A. 1·3 .	,, ,,
Dec.	Merlin's Growing Slide . .	,, ,,

Again your Committee wishes to thank the editors of *The English Mechanic* and *Knowledge* for the publication of reports of our meetings. The report in *The English Mechanic* is published on the Friday following the meeting, and is sent to all country members residing more than twenty miles from London, to keep them informed as to the doings of those more favourably situated.

Your Committee regrets that a change in the dates of meetings has been necessary, and regrets still more the change in accommodation for the Conversational Meetings. The present arrangement cannot be regarded as permanent, although there will be many difficulties to be met with in making more suitable provision.

Nine excursions were arranged for 1908. As usual, that to the Royal Botanic Gardens was the best attended, when 41 members were present. The average attendance at the nine excursions was 21·7, against 19·5 for 1907. The thanks of the Club are due to the Directors of the Royal Botanic Gardens, East London Water Works, and Surrey Commercial Docks, for their kindness in allowing the members to visit and collect in these interesting places.

The Library has been well patronised during the year. It has received several important additions, and is kept well supplied, by exchange, purchase, or gift, with the latest results of microscopical science. These are as follows:—

Peragallo (H. and M.), *Les Diatomées de France*, from Mons. J. Tempère.

Van Heurck (Dr. H.), *Prodrome de la Flore des Algues Marines des Iles Anglo-Normandes*, from the Publisher.

Wright (Sir A. E.), *Principles of Microscopy.*

Sinel (J.), *Outlines of the Natural History of our Shores.*

Balkwell (F. P.) and Millett (F. W.), *The Recent Foraminifera of Galway.*

Wright (L.), *Light.*

West (W. and G. S.), *British Desmidiaceae.* Vol. 3. Ray Society (purchased).

Wesenberg-Lund, *Plankton Investigations of the Danish Lakes.* In exchange.

American Botanical Gazette.

Missouri Botanic Garden.

Smithsonian Reports.

Philippine Journal of Science.

Quarterly Journal of Microscopical Science.

Annals of Natural History.

Memoirs, Proceedings and Reports of:—

Royal Microscopical Society.

British Association.

Royal Institution.

Geologists Association.

Optical Society.

Manchester Literary and Philosophical Society.

Manchester Microscopical Society.

Liverpool Microscopical Society.

Natural History Society of Glasgow.

Natural History Society of Northumberland.

Botanical Society, Edinburgh.

Hertfordshire Natural History Society.

Bristol Naturalists Society.

Royal Institution of Cornwall.

Indian Museum.

Academy of Natural Science of Philadelphia.

The Cabinet has been made good use of by members, but there are no donations of slides to acknowledge this year. Although the collections are fairly representative, there still remain gaps to fill up, and there need be no diffidence on the part of those who prepare slides to present specimens to the Club. Among those groups that are poorly represented may be mentioned :

Protozoa (other than Foraminifera and fresh-water Rhizopods).

Pond Life of all kinds (except Rotifers).

Spiders, whole and dissected.

Algae of all kinds.

Test Diatoms in media of high refractive index are often asked for in vain.

Although there have been no additions, the Curator has taken considerable pains to keep the collections in perfect order by ringing, or even remounting, those specimens that required such attention. For those who are beginning a study of Petrology, Mr. Caffyn has prepared a neat typewritten booklet containing a description, key, sketch, and explanatory photograph of each preparation in a series of fourteen typical examples. The Club's best thanks are due to Mr. Caffyn for this most useful piece of work. The Club's thanks are also due to Mr. C. H. Bestow for his valuable help to the Curator in the issue of slides.

The work of the Treasurer would be greatly simplified if all members would forward their subscriptions as soon as possible without causing the trouble and expense of corresponding. Considering the smallness of the subscription, a request for prompt payment cannot be considered unreasonable.

Your Committee desires to thank the Officers for their services during the past year.

The Club occupies such a unique position and performs such a useful function amongst microscopists that it would be difficult to be other than optimistic as to its future. No prosperity, however, is likely to come automatically, and your Committee hopes that every member will make some effort to promote the well-being of the Club by bringing its advantages to the notice of other microscopists, by adding his own efforts to make the Club more useful, by hesitating less in putting his knowledge and skill at the service of his fellow members, and by allowing the expression of that social instinct which has given the Club its tradition of pleasant usefulness.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB

For the year ending December 31st, 1908.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1907	242	13	6	By Rent	75	0	0
" Subscriptions	184	0	0	" Expenses of Journal	104	11	8
" Dividends on Investments	12	15	0	" Postages	6	13	6
" Sales of Journal	26	9	11	" Printing and Stationery	9	0	9
" Sales of Catalogues, etc.	2	9	5	" Attendant	6	0	0
" Receipts for Advertisements	6	0	0	" Petty Expenses	4	2	0
				" Books, etc.	7	18	5
				" *English Mechanic*	3	4	4
				" Smith Testimonial	2	5	8
				" Balance in hand	255	11	6
	£474	7	10		£474	7	10

INVESTMENTS.

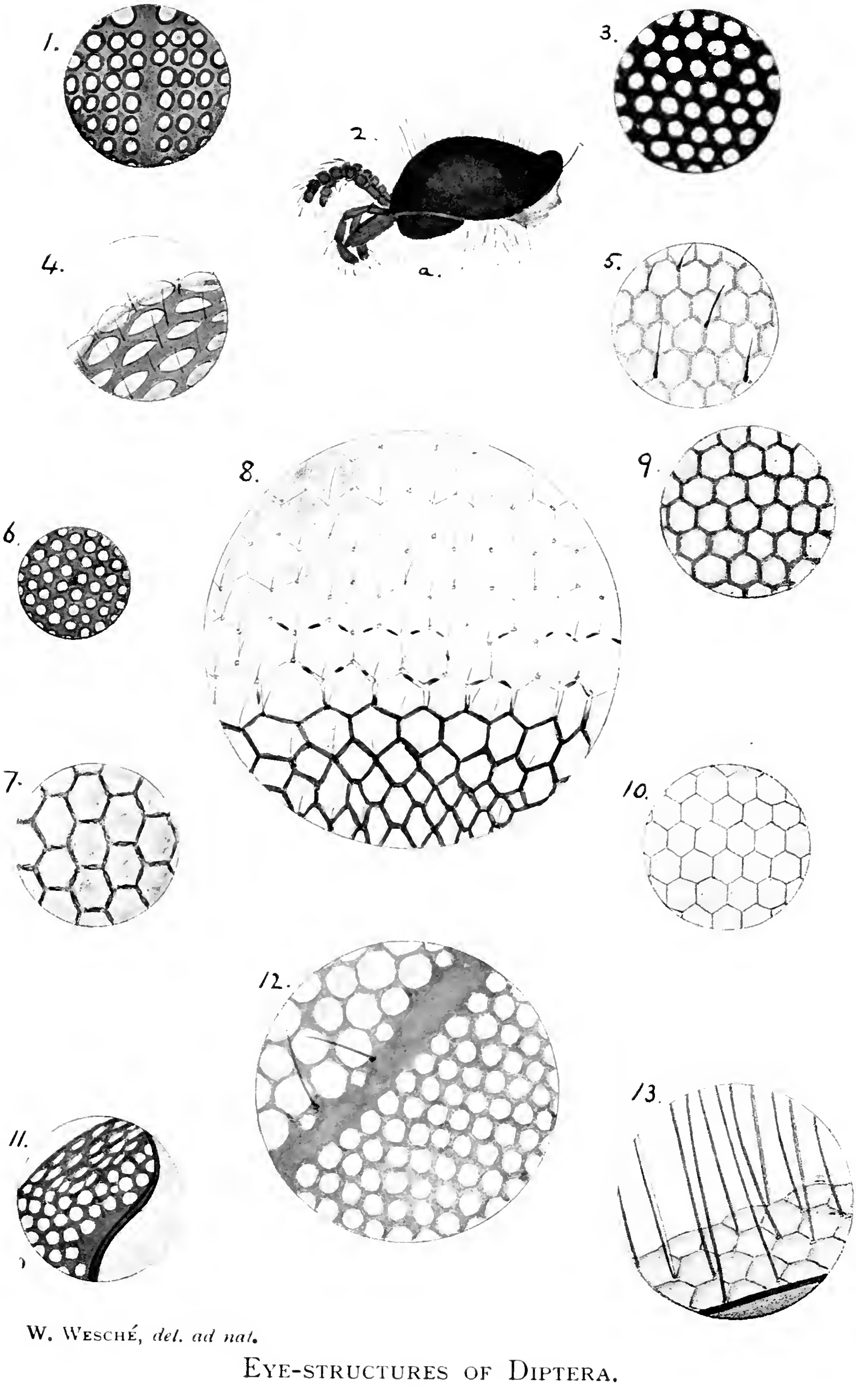
	£	s.	d.
$2\frac{1}{2}$ per cent. Consols	200	0	0
Metropolitan Water "B" Stock	100	0	0
$2\frac{1}{2}$ per cent. Metropolitan Consolidated Stock	100	0	0
$2\frac{1}{2}$ per cent. Annuities, 1905	100	0	0

We have examined the above Statement of Income and Expenditure and compared the same with the Vouchers in the possession of the Treasurer, and have verified the Investments at the Bank of England, and find the same correct.

January 15th, 1909.

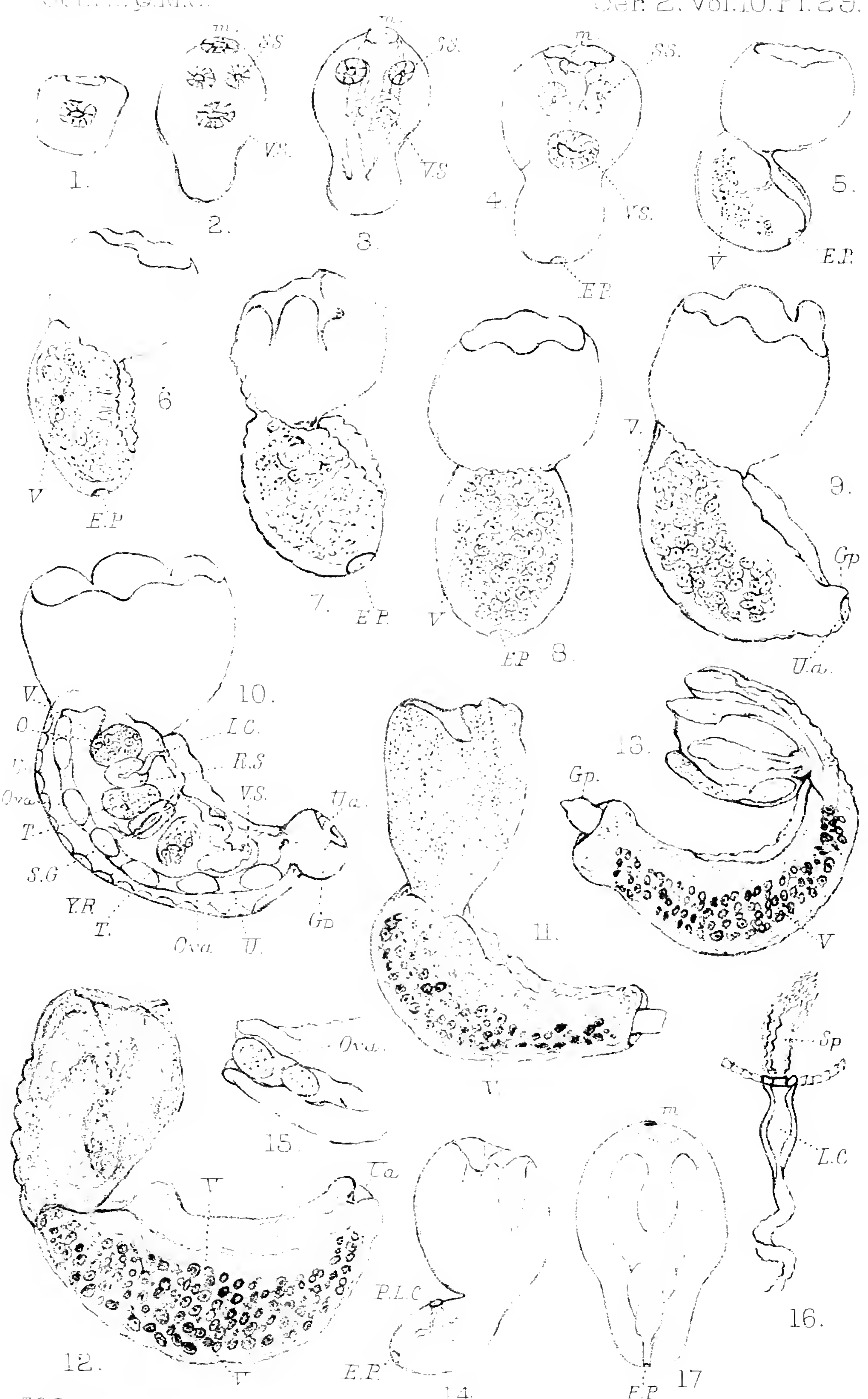
FRED HUGHES } *Auditors.*
C. H. CAFFYN }

F. J. PERKS, *Hon. Treasurer.*



W. Wesché, *del. ad nat.*

Eye-structures of Diptera.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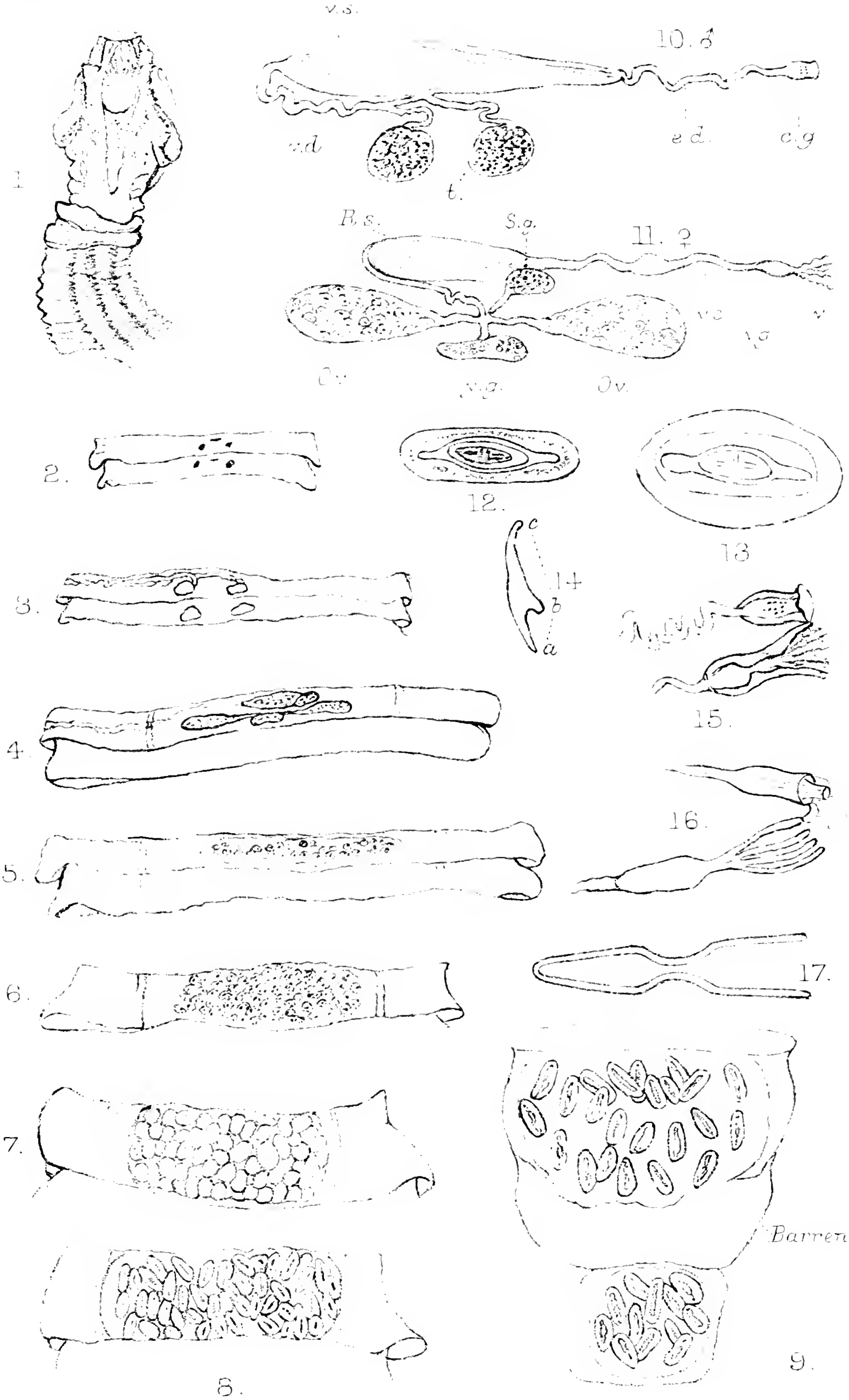
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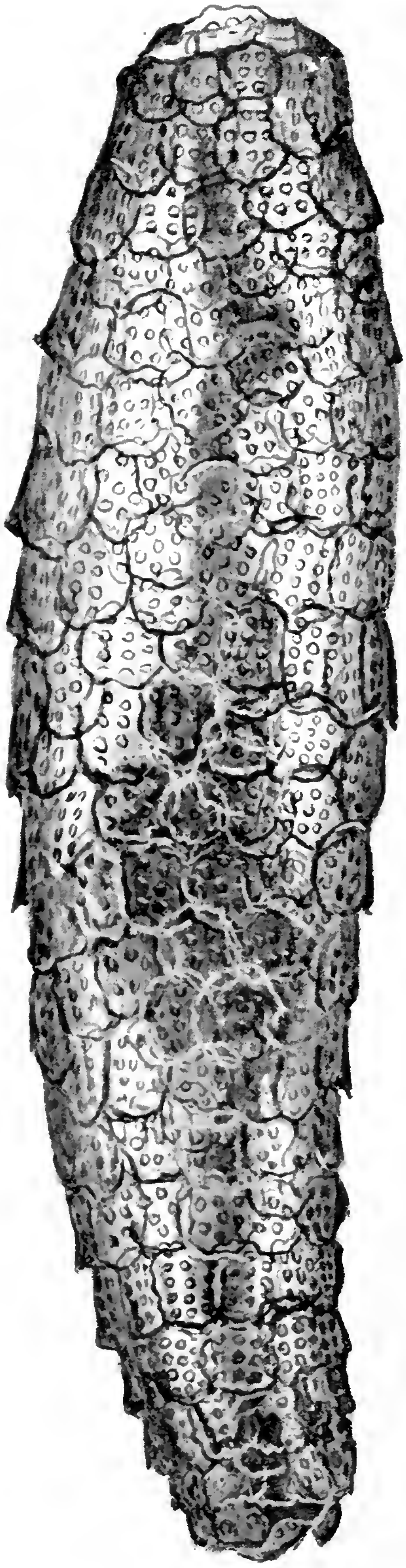
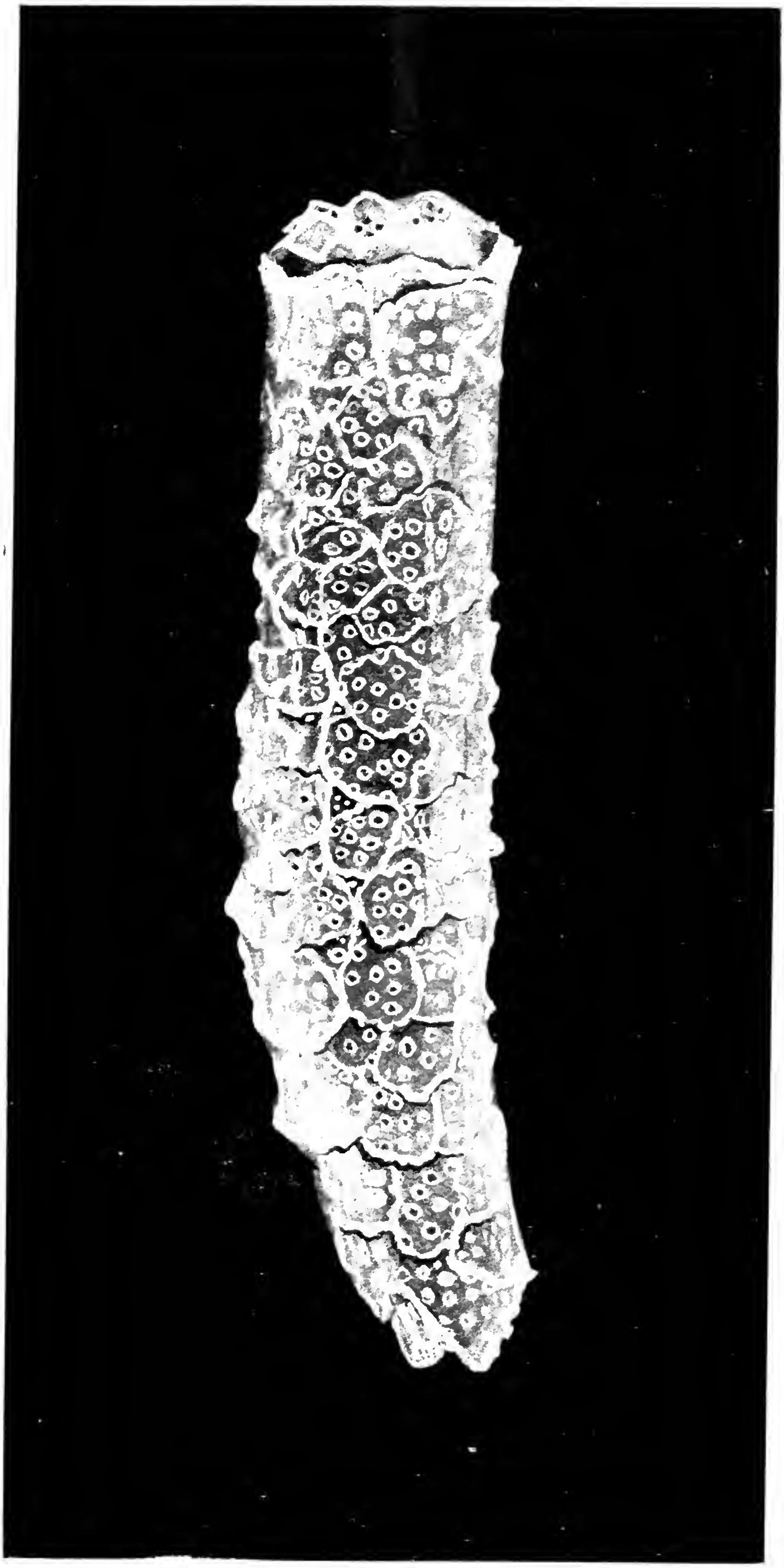


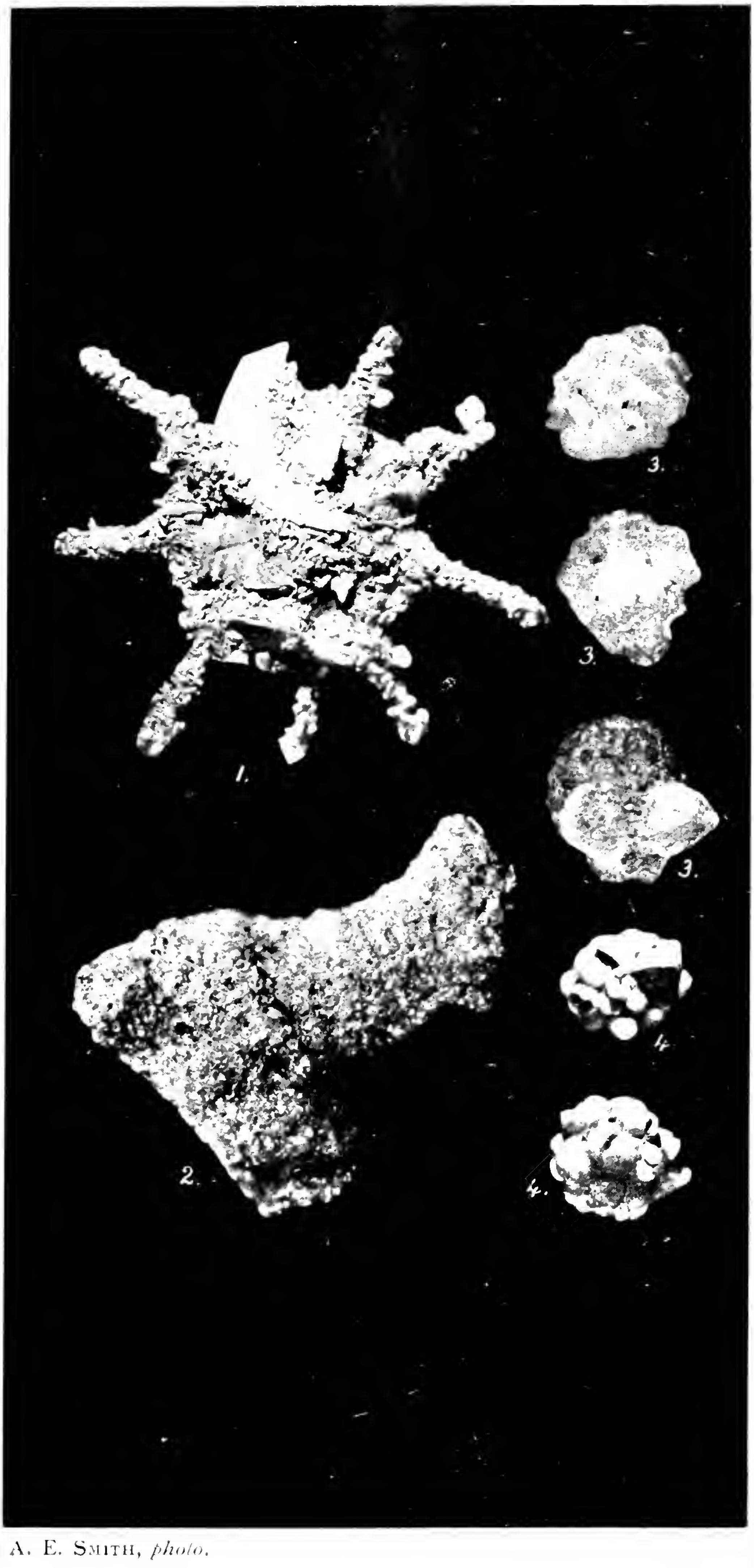
S. C. AKEHURST, *del.*

TECHNITELLA THOMPSONI, sp.n.



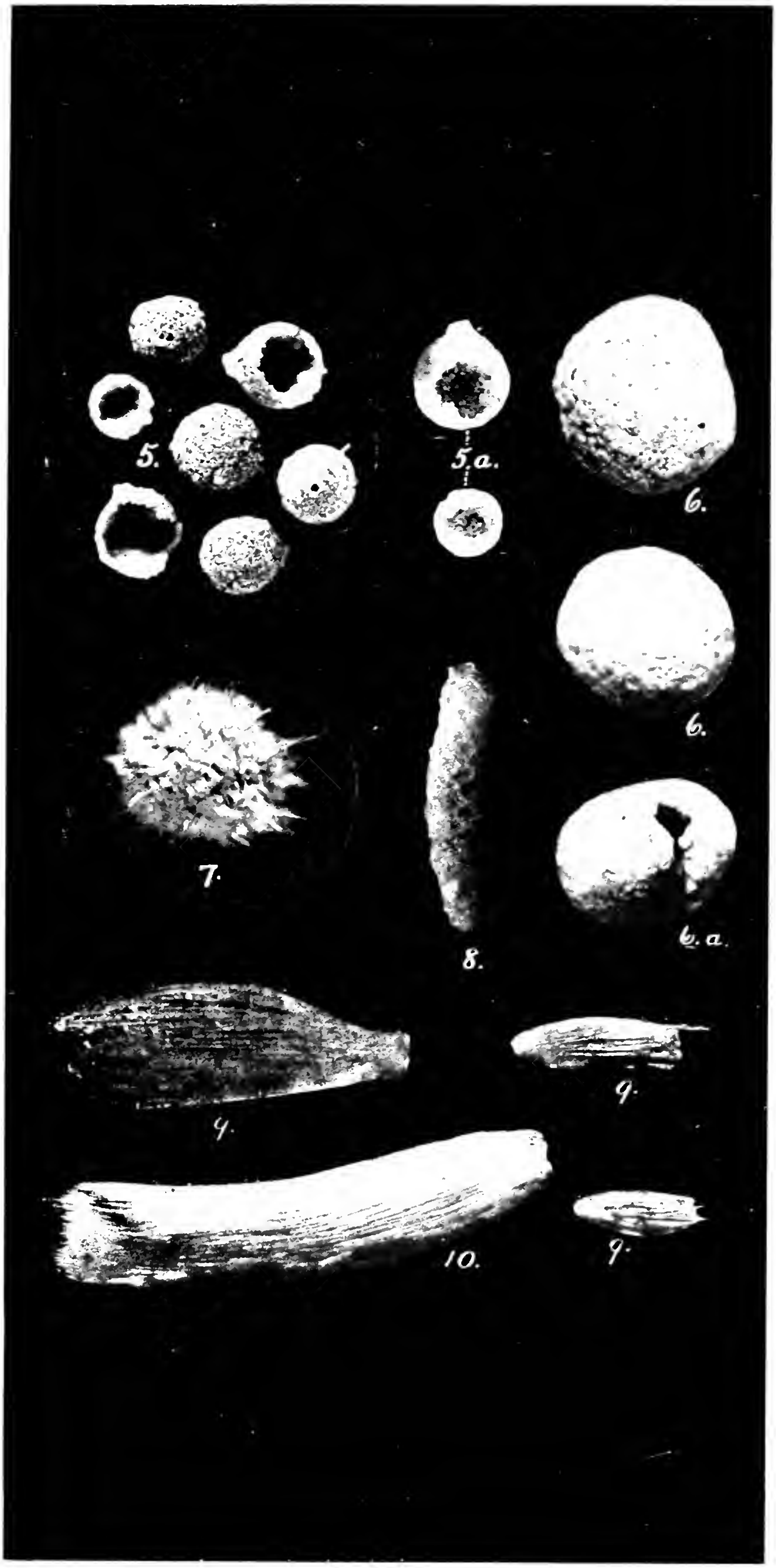
S. C. Akehurst, *del.*

Technitella thompsoni, sp.n.



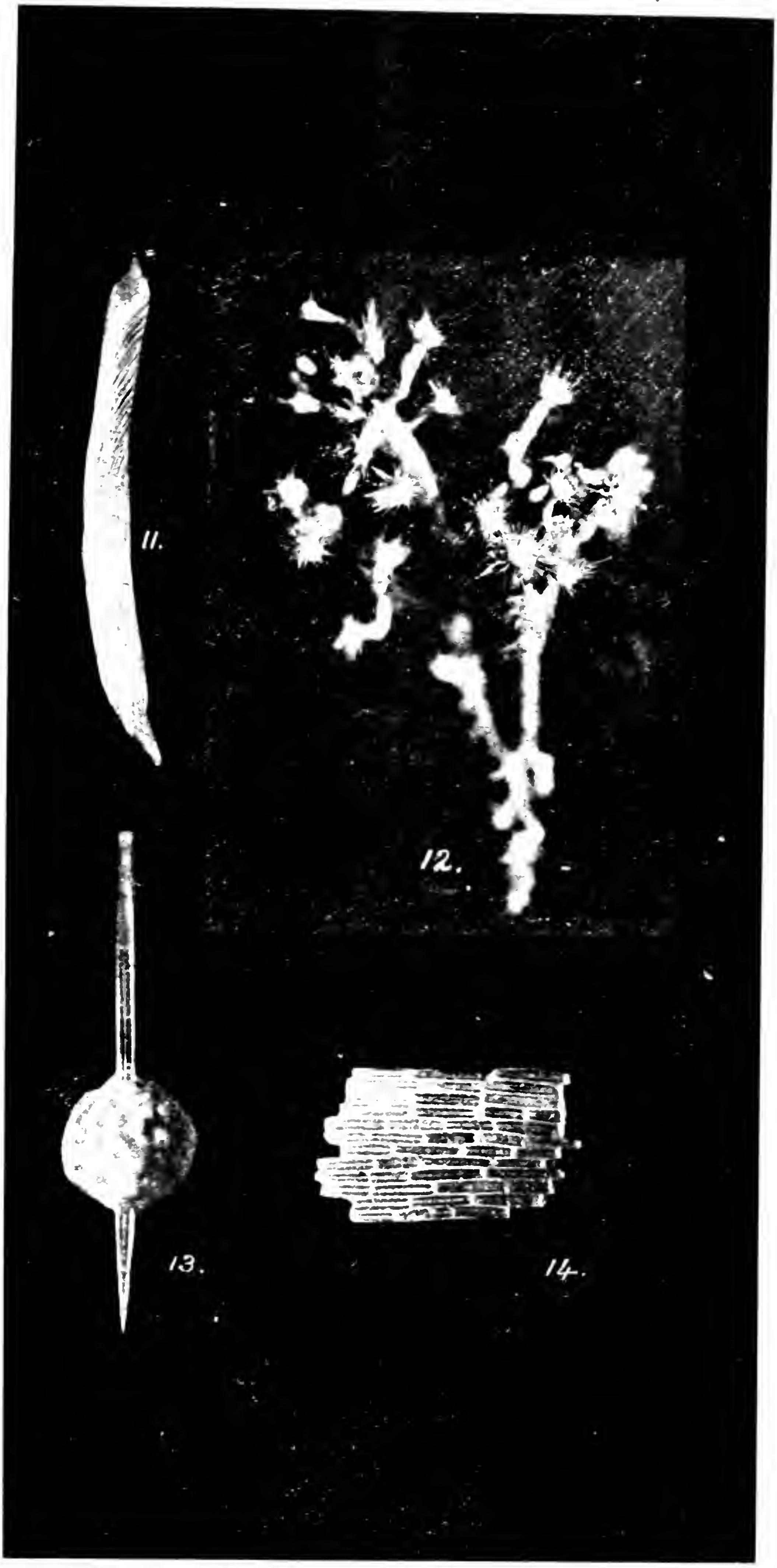
A. E. Smith, *photo.*

Arenaceous Foraminifera.



A. E. SMITH, *photo.*

ARENACEOUS FORAMINIFERA.



A. E. Smith, *photo.*

Arenaceous Foraminifera, etc.

THE PRESIDENT'S ADDRESS.

SOME APPLICATIONS OF MICROSCOPY TO MODERN SCIENCE AND PRACTICAL KNOWLEDGE.

By Prof. E. A. Minchin, M.A., F.Z.S.

Delivered May 7th. 1909.

Gentlemen,—

I esteem it a great honour to be privileged to address you as President of a Club which has so long a record of good work and earnest endeavour, the more so as I am very sensible of my shortcomings as a microscopist in comparison with many of those who have held this position before me, and with my immediate predecessor in particular. For I must confess that, being by nature and inclination a naturalist rather than a physicist, I have never attained to more knowledge of the construction and principles of the microscope than is strictly necessary for its use. My chief interest lies, and has always lain, not in the theory of the microscope, but in its application; not in the instrument itself, but in the objects that are seen with it. I make this admission with regret, for there is no work more useful to science than that of those talented individuals who labour to increase the efficiency and power of the most important of all scientific instruments. My predecessor in this chair, who is the author of an admirable and instructive manual on the microscope, laid before you last year a contribution to a very important branch of microscopical technique. I am not able, I regret to say, to follow his example, and I propose to discourse on some of the recent advances in knowledge, both scientific and practical, that have been gained by the help of the microscope. But before doing so I should like to say a few words about the progress of the Club during the past year.

We have, as you know, passed through somewhat of a crisis in respect to our quarters and place of meeting, which it was feared we might be obliged to change, but fortunately a satisfactory way out of the difficulty has been found, entailing nothing more than a change in the days of meetings. The Club continues to maintain the number of its members, and to show, by the large attendance at its meetings and excursions, its vitality and energy in carrying on its work. The number of papers

communicated in 1908, however, was less than usual. From my experience of the Club I cannot think that this is to be explained by any diminution of enthusiasm amongst the members, though perhaps over-diffidence and modesty may, in some cases, account for backwardness in coming forward with contributions. I venture to think, however, that diminished productiveness is perhaps largely due to a tendency among microscopists to be too diffuse in their work, and to attempt to cover too wide a field. The time is past when a man can expect to make any real contribution to knowledge by spreading his observations over the whole vast range of microscopic objects. In these days, in which the output of research on every subject is enormous, and is increasing rather than diminishing, a man is more likely to make progress and do useful work by taking up a special line and sticking to it. Speaking for those who work *with*, rather than *at*, the microscope, I would advise every one who wishes his work to be fruitful in results to have a hobby of his own. We have amongst our members many shining examples of the value of this method of work, and, as a matter of fact, it is to such that nearly all the original work done by our Club is due. In making this suggestion I do not mean that we are all to become narrow specialists, interested in nothing but our own particular subject. It would be fatal to the social life of our Club and to the success of our meetings if no one could feel any interest in anything that other people are doing. Specialisation in work and in research does not necessarily mean specialisation in knowledge or in interests. The great value of such a club as ours is that by bringing together people occupied in different branches of work it enables one man to know what another man is achieving in a different line, thereby at once widening his outlook and stimulating him in his own work by producing a healthy spirit of emulation.

My advice, therefore, to the microscopist would be that he should aim at wide knowledge and diffuse interests, but should concentrate his activities and focus his attention on his own particular pet hobby, so that, by mastering a branch of natural knowledge, he may find himself in a position to advance it. However limited the field of study may be, however insignificant the objects may appear, yet something can always be found which, on the one hand, will illustrate some important

and fundamental principle, or, on the other hand, will prove ultimately to have some direct or indirect bearing on human life and its needs. Let me give two instances in support of this statement. To the so-called practical man it may seem a very trivial occupation to worry about such things as Foraminifera, however beautiful their shells may be. Yet these tiny creatures, living in a sphere apparently so remote from our own, furnish wonderful illustrations of the powers and activities of primitive living matter, and Mr. Earland has recently drawn our attention to the remarkable property they exhibit of selecting particular materials for building up their houses. This is a most interesting fact, well worthy of further study, especially by experimental methods, for it indicates that the most primitive and formless living matter possesses faculties of a kind which we term in higher forms of life instinct or intelligence. Again, a reputation for being an expert on, let us say, fleas may provoke a smile from the uninstructed; but in view of the proved connection between fleas and human disease, especially plague, these paltry insects have now assumed very great importance as objects of study, and we find detailed descriptions of them in the reports of Government commissions. As Lord Crewe remarked in a recent speech, we commonly speak of any very trivial annoyance as a flea-bite; but we know now that under certain circumstances a flea-bite may cost a man his life. Small wonder, then, that fleas have become important objects of study to mankind.

This question of fleas and plague reminds me that I am here not to preach a sermon, but to give an address, by recalling to my mind the subject which I propose to discuss to-night, namely, some of the remarkable advances that have been made during the last few years in our knowledge of human diseases caused by microscopic parasites. This is a subject which has now grown to such vast proportions that I must confine myself of necessity to a small part of it, namely, the diseases caused by Protozoa. As examples, I shall deal more especially with malaria, sleeping sickness, and yellow fever.

Malaria is a disease which was well known to the ancients, and is still very rife in many parts of Europe. It appears to have been prevalent formerly in the fen districts of England, but to have died out there from some unexplained reason. It is estimated by Prof. Ronald Ross to cause from a quarter to

half the total disease in the Tropics. It occurs under at least three forms, known commonly as tertian, quartan, and pernicious malaria, each of them easily distinguishable clinically, and due to distinct species of the parasite differing from one another in morphological characters, but similar in the general features of their life-cycle.

Until comparatively recent times nothing whatever was known of the nature of malaria, or the manner in which it was acquired. It was generally believed that it was due to a poisonous miasma which arose from swamps and marshes, a notion conveyed in the name malaria—"bad air." This miasma theory is very prevalent in literature; for instance, in such a work as Dickens's "Martin Chuzzlewit," where the unfortunate settlers in Eden are supposed to contract fever by breathing the exhalations of the swamps.

The scientific study of malaria may be dated from 1880, when the parasite was discovered in the blood of fever patients by Laveran, then a military surgeon in Algiers. Laveran examined the blood microscopically, and observed the principal phases of the parasite. It was, however, some years before Laveran's parasite was accepted as the cause of malaria, though it ultimately obtained universal recognition. Even then it remained a mystery how the parasite got into the blood, and many still held to the miasma-theory. It was supposed by some that the parasite passed out of the body and produced cysts or spores which could be disseminated by the wind, just as the cysts of many Infusoria are known to be carried by aerial currents, and that by inhaling these air-borne germs the disease was acquired. Others sought for the source of the infection in the contamination of drinking-water.

It remained for a countryman of ours to discover the true method of infection. Prof. Ronald Ross, then in the Indian Medical Service, experimented first with the very similar malarial parasites of birds, and found that the infection was taken from one bird to another by mosquitoes of the genus *Culex*. Similar experiments on human malaria gave at first negative results, until it was discovered that the necessary intermediate host of human malaria was a mosquito belonging to quite a different genus, *Anopheles*. These experiments were confirmed by many investigators in all parts of the world, and led to results which

may be stated in two propositions, one positive, one negative; first premising that by a malarial infection is meant a new infection, not a relapse in a person previously infected.

1. Malaria can be and is conveyed from sick to healthy persons by the agency of mosquitoes.

2. Malarial infection is not known to take place by any other method.

Experiments further showed, as I have mentioned already, the very remarkable fact that avian malaria can only be transmitted by Culicine mosquitoes, and human malaria only by Anopheline. If human blood containing the parasite be taken up by a *Culex*, the parasite cannot develop, but is digested up, along with the blood. The same thing happens to the parasite of avian malaria when taken up by an *Anopheles*.

Following on these experimental discoveries, the development of the parasite was studied microscopically in all countries by a great number of observers, amongst whom we may mention especially Grassi in Italy and Schaudinn in Germany. By their combined labours the complete life-history of the parasite has been worked out in the greatest detail, revealing one of the most fascinating chapters in natural history.

[An account was then given of the development of the malarial parasite, illustrated by a diagram.]

My second example, sleeping sickness, is also a disease that has been long known, though without attracting, until recently, so much attention as malaria. It was first observed in the West Indies in negro slaves imported from the west coast of Africa, the region in which it appears to be endemic. It was observed that the negroes suffering from it were not infectious, and that the disease did not spread to others—a fact easily explained by what is now known about the transmission of sleeping sickness, namely, that it is effected by flies of the genus *Glossina*, commonly known as tsetse-flies, which are confined at the present time to the African continent.

Of recent years this previously obscure disease has forced itself on the public attention by its having spread from its native haunts on the west of Africa and invaded regions previously free from its presence. In our Protectorate of Uganda, in particular, it has caused terrible mortality, completely extirpating the natives in some parts, and numbering also many Europeans

amongst its victims. I do not propose here to enter into the distressing symptoms of this deadly disease, but only to deal with what may be termed its natural history.

Before it is possible to understand clearly the nature of sleeping sickness it is necessary to say a few words about similar diseases in animals. It was well known to all African travellers from the time of Livingstone that domestic animals, especially cattle, horses, and dogs, were liable in Africa to a peculiar fatal disease known as nagana, caused by the bite of blood-sucking flies of the genus *Glossina*, the tsetse-flies, of which there are several species abundant in various parts of Africa. It was supposed that the fly produced and injected a virus which caused the disease.

The nature of nagana was first made clear by Sir David Bruce, who found that the cause of the disease was the presence in the blood of a minute flagellate or trypanosome, since named *Trypanosoma brucii*, and that the tsetse-fly did not generate the parasite, but was merely the unwitting agent in transmitting it from infected to healthy animals.

When the epidemic of sleeping sickness broke out in Uganda, the Royal Society, at the request of the Government, appointed a commission to investigate it, and Sir David Bruce was sent out as a member of the commission. A trypanosome was found by Castellani in the cerebro-spinal fluid of sleeping-sickness patients, and it was shown by Bruce and his assistants that this trypanosome was the cause of the disease, and that it was transmitted from sick to healthy persons by the bite of the local species of tsetse-fly, *Glossina palpalis*. It was proved by subsequent researches that the trypanosome causing sleeping sickness was identical with one that had been discovered previously in the blood of negroes in Gambia and named *T. gambiense* by Dutton. In short, it was proved that sleeping sickness of man is a trypanosome-disease similar to nagana of animals, but produced by a different species of trypanosome, transmitted by a different species of tsetse-fly, and running a somewhat different course. Whereas *Trypanosoma brucii* remains in the blood of its victims until their death, *T. gambiense* is found in the blood in the early stages of the disease, but spreads, probably through the lymphatic channels, into the cerebro-spinal fluid, and then causes the peculiar nervous symptoms which give the disease its name. The rapid spread of sleeping sickness into regions where it was previously unknown

is an indirect consequence of the occupation of the African continent by European Powers. Formerly the native tribes were constantly at war with one another, and a negro never travelled any great distance from his own village. Now caravans move in every direction, and doubtless in this way the disease has been spread by porters and other natives already infected with the trypanosome coming into regions where tsetse-flies abound, and there infecting the flies, which in their turn have disseminated the infection amongst the previously healthy population.

Although it was proved experimentally that the disease is propagated by tsetse-flies, the exact method by which this is effected has remained hitherto somewhat mysterious. It was proved that the infection could be conveyed by what may be termed the direct mechanical method; that is to say, that if a fly has sucked recently the blood of an infected person, its proboscis may contain living trypanosomes, and if it inserts its proboscis, immediately or in a short time afterwards, into the skin of a healthy person, it may convey the infection simply by means of its contaminated proboscis. Experiments showed that infection in this direct manner only took place up to forty-eight hours after the fly had fed on the infected subject, and all attempts to obtain infection with flies at a longer interval than forty-eight hours gave negative results. Experimental evidence was therefore lacking for the existence of a developmental cycle of the parasite in the fly, although it was argued by many writers that for various reasons such a cycle must exist. Quite recently, however, a positive result has been obtained by Prof. Kleine, Director of the German Sleeping Sickness Commission in German East Africa. Experimenting with nagana by feeding a batch of flies first on an infected animal and then on a long succession of healthy animals, he has made the most interesting and important discovery that the flies are not infectious at all until some three weeks after their first feed, and that then they infect every animal upon which they are fed. This result indicates that the incubation-period—that is to say, the time occupied by the parasite in its cycle of development in the fly—is far longer than any one had suspected, and that the negative results of former investigators are to be explained by their experiments not having been extended over a sufficiently long period. It must be borne in mind that to those working in Tropical Africa it is often difficult

or even impossible to obtain a sufficient number of experimental animals for such a protracted series of experiments.

From Prof. Kleine's experimental results it is evident that the trypanosome of nagana, and doubtless of sleeping sickness also, does undergo a cycle of development in the tsetse-fly, and the way is now open for the microscopist to rush in and to observe what becomes of the parasite in this long period that elapses between its being taken up by the fly and being given out again. We may expect that a fascinating and wonderful history will be made known of the transformations and migrations, the amours and the increase of the trypanosome in the bowels of the unconscious tsetse-fly. And we seem now to be in sight of a solution to the baffling problem of the transmission of diseases caused by trypanosomes.

The third disease I have chosen for my discourse, namely, yellow fever, is one sufficiently well known to every one, by repute at least. There is no need for me to describe at length the dreaded "Yellow Jack," a malady often fatal, and always excruciatingly painful. The connection of this disease with mosquitoes has long been suspected, and has recently been proved conclusively by both the American and French commissions sent out to study the disease. The mosquito in this case is neither a *Culex* nor an *Anopheles*, but one belonging to a distinct genus, namely, *Stegomyia fasciata*, sometimes called the Tiger-mosquito. It has been proved conclusively that the mosquito does transmit yellow fever, and it has also been proved that the disease is not communicated by direct infection or contagion through contaminated clothes or dwellings. And here let me draw attention to one great obstacle to conducting experiments on yellow fever—the fact, namely, that the disease is not communicable to animals, but only, so far as is known, to man. Hence experimental studies on the disease could only be performed on men who offered themselves voluntarily for this purpose. Such experiments were sometimes negative, sometimes positive, in their result; in the latter case, of course, the subject of the experiment acquired the disease, and in one case at least died of it. It would require the pen of a Shakespeare or a Milton to do adequate justice to such devotion on the part of these brave men to the cause of science and humanity.

By numerous carefully devised experiments a number of

important facts relating to the transmission of yellow fever were elicited. It was shown that the unknown cause of the disease is in the blood of the patient only during the first three days of the illness, so that only during this period can mosquitoes become infected by sucking the blood of the patient. Consequently if the patient be protected from mosquitoes for the first three days he ceases to be a danger to the community as a source from which the infection can spread. It was shown further that the mosquito, after acquiring the infection, goes through an incubation period of from twelve to fourteen days, during which it is not infectious; but after that it is infectious for the rest of its natural life. And a further point of interest was added by the French commission—namely, that an infected mosquito may transmit the infection to its offspring, so that a mosquito which has never fed on an infected person may be congenitally infectious.

I have chosen the instance of yellow fever to put before you because, although we have now such an accurate knowledge, gained by experiment, of the cause and transmission of the disease, no one has succeeded as yet in seeing the parasite itself. It is practically certain for many reasons that there is some minute parasite at work, and there are grounds for suspecting that the parasite is a spirochaete, one of those minute, actively flexible, thread-like organisms of which the affinities are so much in dispute at present, and which some authorities class with the Protozoa, others with the Bacteria. But here we have a case where the microscopist has been baffled, and where we get beyond the present limits of the powers of our instrument, a fact which should make us appreciate the labours of those who study the microscope and strive to perfect it.

Did time permit, I might mention many more important discoveries in the field of Protozoan parasites causing disease. For example, there are the blood parasites of the genus *Piroplasma* (*Babesia*), causing fatal forms of haemoglobinuria in various animals; they are not yet known for certain in man, but a species is known from monkeys, a source which is getting perilously near to us. Here the agent of infection is a tick of some sort, and usually the infection goes through two generations of ticks, being transmitted from the mother-tick, which has acquired the infection, to the numerous progeny of minute six-legged tick-larvae, which in their turn infect the vertebrate host.

Then there are the relapsing fevers caused by spirochaetes in the blood, and said to be transmitted in Europe by bed-bugs, but in Africa by a species of tick which lives in mud floors. In India and other parts of the Tropics we find that the deadly disease known as kala azar, due to a parasite, is transmitted in all probability by bed-bugs. All these and many others furnish points of great interest, but I must be content with the three examples with which I have dealt in more detail, in order to show you how great a work has been done and is being done in this field. As Prof. Osler said recently, these discoveries are going to have an enormous influence on the history of the world and of mankind, because they are going to make the Tropics habitable by white men. We hear or read so often of such-and-such a country being uninhabitable by Europeans on account of its deadly climate; but when we look into the matter we find that it is not the climate at all that is to blame, but that the white races are killed off by diseases caused by some animal parasite with which they are inoculated by the bite of some blood-thirsty arthropod. Take Uganda, for instance, with which I have a slight acquaintance: all that the climate does for you there is to give you a sunstroke if you go out in the heat of the day with inadequate headgear, and to make it very difficult to keep awake after lunch. Some well-known European diseases, such as small-pox and syphilis, are also rife there; but on the other hand, some of our familiar plagues, such as tuberculosis, rheumatic fever, and influenza, appear to be absent. The diseases that are really to be feared are all such as spring from bites of arthropods. If you protect yourself from the mosquito you will not get malaria; avoid the tsetse-fly, which is very easily done, and you are safe from sleeping sickness; do not sleep on mud floors, nor pitch your tent on old encampments, and relapsing fever will not trouble you; keep rats and fleas at a distance, and you are safe from plague. With a little care and attention to surroundings the European finds his life in the Tropics if anything more free from disease than in our temperate but influenza-ridden, palaearctic climate.

In the foregoing remarks I have drawn attention more particularly to the practical results of microscopy wedded to sagacious experiment, and have tried to show how fertile in good results this union has been, and promises still to be. But I

would not have you go away with the impression that I advocate such studies solely on account of immediate practical good to be derived from them. Far from it. I am one of those who hold so-called theoretical and unpractical studies to be of the highest importance, and worthy of all support, if only for the reason that, being unremunerative, they often cannot support themselves. All history shows us that the knowledge of general principles must precede their application and practice, and that what is purely theoretical in one generation becomes thoroughly practical in the next or in a later one. There is no need for me to waste your time by multiplying instances of this familiar truth. But I will conclude with a few words on the wider applications of microscopy.

In the range of the natural sciences, two branches of knowledge stand at opposite poles, as judged from the standpoint of the objects with which they deal. The science of astronomy deals with the infinitely great; the science of biology, on the other hand, with the infinitely small. The astronomer with his telescope astounds us with the distant worlds he reveals to us; he thinks in millions of miles as ordinary persons deal with feet or yards; and he exhibits to us this world on which we live as but an insignificant planet, one of many, whirling round a star far inferior in magnitude to many of those we see nightly, a tiny speck in the vast ocean of space and matter, peopled by a race of puny creatures who style themselves the lords of creation, although their dominion does not extend over a billionth part of the universe. "The consciousness of an endless series of worlds," said Kant, "destroys my sense of importance, making me only one of the animal creatures which must return its substance again to the planet (that, too, being no more than a point in space) from whence it came, after having been in some unknown way endowed with life for a brief space."

Not less astounding, but in a totally different way, are the revelations of the biologist with his principal instrument of research, the microscope. With this he discovers continually new worlds invisible to the unassisted eye, and reveals infinite complexity in things apparently the most simple. We find, in the first place, our own bodies to be microcosms, small worlds, that is, of such inexhaustible variety and elaboration of detail that to the human mind they are as difficult to comprehend and

to realise in their entirety as the macrocosm or great universe itself. We find further that each human body, itself appearing as a single individual or unit, is in reality made up of many billions of living units or cells, each as much á microcosm as the whole body. And thus our instrument, the microscope, brings us face to face with the greatest mystery in the whole range of the sciences, namely, the problem of life and living matter. There is, apparently, no gap in nature so profound as that which separates the living from the not-living. The nature of life, its origin and destiny, the laws that govern living matter and vital processes of all kinds; these are of all problems not merely the most fundamental in science and philosophy, but also the most important for our practical knowledge and daily conduct.

It would be futile to assert that human science has as yet made any great advance in elucidating the nature of life. On the contrary, all progress in research only throws into greater relief the difficulty of the problem; the better we become acquainted with it, the more the mystery deepens. Nor would it be right to assert that the microscope is the sole instrument of research in this field. Our knowledge of the properties and activities of the living substance and of living things advances daily by leaps and bounds through methods of investigation in which the microscope plays no part. I have referred to the knowledge that has been gained of the life-history of the parasite of yellow fever, in spite of the fact that the microscope has failed completely, so far, to detect the parasite itself. But we may safely claim that the greater and most important part of modern biological knowledge could not have been gained without the instrument which it is the object and purpose of our Club to study, to perfect, and to apply; and, further, that to be able to see the objects with our own eyes makes them much more real and true to us than merely to infer their presence and properties from experiments in the dark, so to speak. "Seeing is believing" is an English proverb which has its counterpart in all languages. We may be satisfied in our minds as to the existence and behaviour of the yellow-fever parasite, but nevertheless its discovery by optical means would be greatly welcomed as an important advance in our knowledge.

There is no greater stimulant to the all-important study of living things than the feeling of wonder and delight which the

first sight under the microscope of objects otherwise invisible produces in even the most uninstructed mind. Most of us probably can date our first interest in minute living objects from the time when, perhaps in early youth, we were given, or allowed to use, a microscope, with which we could gratify, without satisfying, our curiosity in looking at all kinds of minute objects. In such an occupation the appetite comes with eating, as the French proverb says, and the instrument which was at first a fascinating toy leads us on until, one might almost say, it masters and enslaves us. In this development there is another instance of the parallel between the progress of the individual and the history of the race. To the majority of early microscopists the microscope was but a toy, an instrument which competed with the magic-lantern as an amusement for drawing-room séances, and only a serious minority made use of it as a means of earnest scientific investigation. There are perhaps still microscopists whose chief delight is to thrill their friends, especially those of the fair sex, by the sight of hairs on a spider's leg, or the elephantine proportions of a cheese-mite. If so, let us not scoff, as some do, at the amateur; we ought rather to regard him with the same interest that a zoologist looks on an okapi or a lepidosiren, as a living representative of a bygone age. For the modern microscopist is fearfully in earnest, and has but little opportunity for amusement in pursuing a science which taxes not only his brain, but his eyes, to the utmost. There is scarcely any greater physical strain than the long-continued investigation carried on with the highest powers of the microscope, and in my own experience I have known some who lacked the physical endowment for such work, and others who have been obliged to retire disabled from the field. Let us, then, in a pursuit which but too frequently dulls enthusiasm by fatigue and exhaustion, in which our "native hue of resolution" tends to become "sicklied o'er by the pale cast of thought," rather envy those who retain the freshness of their early delight, and strive to cultivate, rather than to stifle, that feeling of wonder and curiosity which should be the starting-point of all philosophical and scientific investigation. "Two things," said Kant, "fill my mind with ever-renewed wonder and awe, the more often and the deeper I dwell on them—the starry vault above me and the moral law within me." I venture to think that had Kant lived

in our days he would have found a third source of wonder in the contemplation of the simplest living things as revealed by the microscope, in the combination they present of apparent simplicity with infinite complexity, and of extreme minuteness with the most extraordinary powers. To me the observation of a minute organism, such as an amoeba, under the microscope, is in its way as marvellous as the sight of the starry firmament. I see a minute, formless creature, without definite parts or organs, which nevertheless exercises all the functions of life and exhibits the germ of every faculty we possess, and thereby proves that its apparent simplicity and formlessness cloak a complexity of organisation far transcending our powers of observation and eluding our means of detection. What again can be more wonderful to contemplate than the fact that peculiarities in the complex mental endowment and physical structure of a human being can be transmitted from one generation to the next through the medium of a spermatozoon, the tiniest cell of the human body, in which the microscope reveals only a structure of the simplest kind? These things must rank with the most wonderful and inexplicable of the phenomena that nature presents to us, and we are as yet only on the threshold of investigation. The stellar universe has been observed, its laws and motions studied, for many thousands of years, but our acquaintance with the beginnings of life and its properties as exhibited by the simplest living things is but an affair of yesterday, as it were, and the scientific study of life is as yet in its infancy.

In these days of vast and rapid increase of knowledge in such matters there is danger that we may lose the true perspective, and that our perception of the whole may be blunted and obscured by the immense mass of detail which forces us to attend only to a small part of our science. It is the special function of a club such as ours to keep fresh our enthusiasm and to enlarge our outlook by contact and intercourse with those working in other fields, to spread the infection, if I may use the term, of intelligent curiosity in the minutest natural objects, and thereby to attract and enlist new workers in a field in which the harvest is plentiful but the labourers are few.

NOTES ON THE LIFE-HISTORY OF THE TACHINID FLY, *PHOROCERA SERRIVENTRIS*, RONDANI, AND ON THE VIVIPAROUS HABIT OF OTHER DIPTERA.

By W. Wesché, F.R.M.S.

(*Read October 26th*. 1909.)

Plate 36.

In 1906 I figured and described the remarkable ovipositor of this fly.* I could not explain nor understand its use, and in January 1908 I mentioned the biological problems presented by its morphology and surroundings.† At Mersea Island, on the Essex coast, during the past summer I was able to capture and watch a certain number of this species; they were never very plentiful, and are difficult to recognise, as they behave in a similar manner to a number of flies of about the same size, and their general appearance is much like that of a number of other Tachinidae, which also have very hairy eyes, are greyish black with white shimmer, and are clothed with many strong spines; consequently, till the insect was captured and examined with a lens. it was impossible to be certain that it was not *Blepharidea*, *Plagia*, *Frontina*, or one of the smaller *Sarcophaga*.

It was usually seen quietly resting on a leaf, often that of a bramble (*Rubus fruticosus*) which formed part of a hedge that was my habitual hunting-ground. Judging by my captures

* Genitalia of Diptera, W. Wesché. *Trans. Linn. Soc.* Ser. II. Zool. vol. ix. p. 364, 1906.

† *Jour. R. Mic. Soc.* 1908, pp. 421–2.

the males were present in greater numbers, about two to one female. The latter, like most of the Tachinidae that I am familiar with, had none of that restless energy that sometimes characterises the predaceous insects, particularly the Ichneumonidae. In fact, as I said before, it was always seen in a position of rest; but there are moments in its life when it must exert a very violent energy.

So much for its general characters; as to the microscopical, for the convenience of my readers I will recapitulate some of the facts that I have recorded in previous papers. The female is provided with a relatively very large, strong, sharply pointed hook, not at all unlike a sting, which is folded back under the abdomen, and lies when not in use in the median line (Fig. 1). Besides this there are chitinous ventral plates which are cleft, and allow the hook to rest on the soft membrane of the stomach. These plates are strongly spined along their outer edges, not with ordinary sharp setae, but with very strong knife-like structures. This is a very striking feature, and suggested Rondani's name of "*serriventris*," a much more descriptive designation than Meigen's "*concinnata*"; as I shall show later, the ideas of neatness and prettiness of appearance are lost when we come to regard the application of the specialisations on the abdomen.*

When examining these curious structures on my preparations, I noticed the jaws of larvae, and was thus able to establish the fact, which is well known of some other groups of flies, that *Phorocera serriventris* is viviparous and brings forth living larvae, not laying eggs like the vast majority of insects. In a single female, certainly of full size, I counted ninety-eight jaws of larvae, and probably some were hidden under the numerous

* The synonyms of this insect are very numerous and fill a page of a Hungarian catalogue. I regret that the misdirected energy of some person has unearthed a clumsy generic name of Bouché, 1834, *Compsilura*; and the many times renamed fly is in future to be known as *Compsilura concinnata*, Meigen. Why cannot nomenclature, like bad debts, have a Statute of Limitations?

strong spines with which the abdomen is thickly studded; as I shall show later, by observations on other species, this is an unusually large number (Figs. 2, 3, 9). The plates on the abdomen have their spines opposed in direction to that of the point of the hook, and, in conjunction with the fact that the insect is viviparous, afford a very remarkable problem; as I said before,* the question arises, "To what use does an insect put an ovipositor when that insect does not lay eggs?"

I can now answer that question; but the subject is not a pleasant one, and it seems one of the cruellest in Nature.

It has been recorded by Schiner † that the fly has been bred from the pupae of larvae found in the caterpillars of *Sphinx pirastri* (which, unless that is a misprint for "*pinastri*," the pine hawk moth, is a foreign species), *Liparis* (= *Porthesia*) *chrysorrhaea*, L. (brown-tail moth), *Leucoma salicis*, L. (white satin moth), and *Pieris brassica*, L. (large white butterfly). In the cabinet of the British Museum (Natural History) is a small caterpillar of *L. salicis*, L., and another of *Bombyx neustria*, L. (lackey moth), from which this fly has been bred in Britain. Putting together the points observed with the microscope—the viviparous condition, the piercing hooks and opposed serrations—with the records of Schiner and the Museum, it can be understood that living larvae are introduced into the unfortunate caterpillar, the fly making an aperture for their entrance by forcing the hook into its victim, the necessary purchase being obtained from the grip of the plates on the caterpillar, giving a hold in an opposite direction to the force expended on the penetrating hook. Well might Tennyson sing of:—

Who trusted God was love indeed,
And love Creation's final law,
Though Nature, red in tooth and claw
With rapine, shrieked against his creed. ‡

Putting the cruelty aside, the Lepidoptera preyed on are

* *Jour. R. Mic. Soc.*, 1908, pp. 421-2.
† *Die Fliegen*, vol. i. p. 489.
‡ *In Memoriam*, lvi.

destructive to crops, and harmful to various plants, and *Phorocera* must be considered, from the economic point of view, a useful, if cruel, insect. It is obvious that many caterpillars are attacked by a single female, as one could scarcely carry ninety-eight parasites.

Another species (*P. lata*, Ztt.) has been bred from a saw-fly (*Lophyrus pini*), and these insects are, like the moths and butterfly, destructive, as they greatly damage the pine forests.*

The parasitism of Diptera on Hymenoptera is rare compared with the constant attack of the Tachinidae on Lepidoptera.

By means of the microscope it is possible to detect the viviparous condition of flies, if the specimens are properly cleared and prepared, as the hard chitinous jaws are not dissolved by potash, and are very characteristic in appearance, showing through the cleared plates of the abdomen. I have already published my observations on four insects: *Oliviera lateralis*, F., *Plagia trepida*, Mg., *P. serriventris*,† and *Phora ruficornis*, Mg.,‡ and I now add to that list *Myioba fenestrata*, Mg., and *Siphona geniculata*, Deg.

According to Schiner, the metamorphosis of *Oliviera* is unknown, and I am unacquainted with any later observations; I counted over twenty-five jaws in my preparation (Fig. 4).

The larvae of *Plagia* are parasitic on caterpillars, and have also been found, like those of *P. lata*, on *Lophyrus pini*; this insect can also be ranked as beneficial to man, but its capacity for usefulness is less, as I found under twenty jaws of larvae in my preparation, a great contrast to the more prolific *P. serriventris* (Fig. 7).

Phora ruficornis is somewhat singular, as the large majority of Phoridae lay eggs; but it belongs to a family the species of which are small in size, but great in numbers, and present many curious features and anomalies in life-history. There are a number of wingless species, and some are recorded as living in

* *Die Fliegen*, vol. i. p. 489.

† *Jour. R. Mic. Soc.*, 1908, p. 421.

‡ *Trans. Ent. Soc. Lond.* 1908, Pt. II. p. 291.

caves both in Europe and America, while many others have been found in the nests of ants. Another, from British East Africa, was so like a cockroach that it was sent as such to Mr. R. Shelford, who formed a new genus (*Aenigmatistes*) for its reception.* I have two preparations of *P. ruficornis* showing larvae, which were given me by that great authority on the British species, Dr. J. H. Wood, of Tarrington; they differ much from the Muscid type, and the jaws are quite invisible, but the segmented body and rather rough skin make them easy to recognise. One female contains two, and the other six, larvae. It may be noted that the ovipositor differs from the usual type of the part in the Phoridae, and has a serrated chitinous process at its end, which has a very faint resemblance to the ovipositor of some Phytomyzidae, and suggests a mining habit; but the larvae of other species of the genus are parasitic on insects or live in decaying vegetable matter, dung, and fungi (Agaricus), and one has been found parasitic on a snail.†

Myioba fenestrata is very similar in general habits to *Oliviera*, being very often seen on flowers, especially "*compositae*." Schiner ‡ quotes Macquart as saying of the larvae, that they, like *Miltogramma*, are found side by side with the larvae of some Fossorial Hymenoptera, whom they seek out, and that Saint-Fargeau had found them on the bodies of beetles (Curculionidae). I found the jaws of twenty-eight larvae in my preparation (Fig. 6). *S. geniculata* is a very pretty small fly with a remarkable, long proboscis, § with which it is often seen probing the nectaries of flowers. It has been bred from the caterpillar of one of the Noctuae, on which the larvae are parasitic; these moths, like the fly, are exceedingly plentiful. In my preparation I only found two perfect jaws, but I found the earlier stages of about eight other larvae; this suggests a gradual process of bringing forth young, one being born at a time. We have some experience

* *Aenigmatistes africanus*, R. Shelford, M.A., F.L.S., *Lin. Soc. Jour. Zool.*, vol. xxx p 150 March, 1908.

† Schiner, *Die Fliegen*, vol. ii. p. 336.

‡ *Ibid.*, vol. i. p. 514.

§ *Journ. R. M. Soc.* 1909, plate iv. fig. 58.

of such a condition. I have a note that the Anthomyid, *Hylemyia strigosa*, F., brings forth living larvae, one at a time, but this is doubtful, and is contradicted by Schiner, but there is no doubt that *Glossina palpalis*, Des., has been found by Professor Minchin to have a somewhat similar organisation * (Fig. 10).

There is a Muscid fly in New Zealand which is reported to be viviparous, the larvae being dropped on blankets; besides this I know of only two more genera (there are probably a great number) in which the viviparous condition is found. Schiner describes *Sarcophaga* and *Onesia* as being "vivipar." In the last genus it is of some importance as a natural generic character, as the morphological characters appear to include the species in *Calliphora*, with our well-known blow-fly, whereas it is placed by Schiner close to *Sarcophaga*.

In conclusion, there is one point which perhaps might have been mentioned earlier; it is that of a secondary sexual character of many Tachinids. In Robineau-Desvoidy's rather heterogeneous genus of *Nemoraea*, which has been so much split up by later systematists, it is stated that the fore tarsi of the females are often dilated, while those of the males remain unaltered.† This is also the case in *Polidea*, and strikingly so in many exotic genera. I was at a loss for an explanation of this specialisation. In many genera it is found as an exclusively male character, and the reason for its existence is simple and obvious. But till I came to consider the case of *P. serriventris*, which has perfectly simple tarsi on the forelegs of both sexes, I was exceedingly puzzled. But when we remember that it is only the females that attack the Lepidopterous larvae, it is at once obvious that the fore tarsi have become modified to contain the larger muscles, necessary to enable the flies to maintain a firm hold of the caterpillars while ovipositing.

I would like to add two observations which have been made since the above was in type.

* *Proc. Roy. Soc.*, vol. xiii. 76, 1905, p. 543.

† *Die Fliegen*, vol. i. p. 447.

1. I have prepared and examined one of the *Phorocera* captured at Mersea in August, and I cannot find any trace of larvae. The gravid insects were captured in the month of June in a garden in South Hampstead. These facts throw further light on the life-history, as they suggest that the Mersea captures had been recently hatched out, a supposition well supported by their beautiful condition, and were then preparing to breed; finally making an attack on some late autumn caterpillar, spending the winter as pupae in the host, and appearing and mating early in the spring. This accounts for the several species of Lepidoptera that are attacked.

2. I have also found larvae in the female of *Blepharidea vulgaris*, Fln. I counted fifty-five in the abdomen of my preparation, but there are probably at least ten more. They are much serrated on the surface, and have characteristic jaws with the distal end blade-like. The imago has been bred out of *Plusia gamma*, L. (Silver Y moth), one of the commonest species (*Die Fliegen*, vol. i. p. 458).

Explanation of Plate 36.

Fig. 1. Diagram of the abdomen of the female of *Phorocera serriventris* Rnd.; lateral view to show the relative position of the parts. All the setae and hairs are omitted. *a*, hook; *b*, serrated plates.

,, 2. Jaws of larva of *P. serriventris* to show the appearance as seen with low powers when viewed through the cleared plates of the abdomen; lateral view.

,, 3. The same, seen in another position.

,, 4. Jaws of larva of *Oliviera lateralis*, F., seen in the same manner as Fig. 3.

,, 5. The structures and spiracles at the anal end of the abdomen of *P. serriventris* highly magnified. Drawn from a specimen taken out of the abdomen of the fly and cleared in potash. *s*, spiracle.

Fig. 6. Jaws of the larva of *Myiobia fenestrata*, Mg., seen in the same manner as Fig. 3.

,, 7. Jaws of the larva of *Plagia trepida*, Mg., seen in the same manner as Fig. 3.

,, 8. Same as Fig. 5, but drawn from another larva, and giving a different view of the parts.

,, 9. Larva of *P. serriventris*, drawn from a preparation of a specimen taken out of the fly, and cleared in potash; lateral view. *a*, jaws with accessory structures at distal end; *s*, spiracle; *b*, short serrations on ventral side used in locomotion.

,, 10. Jaws of larva of *Siphona geniculata*, Deg., seen in the same manner as Fig. 3.

NOTE.—Figs. 2, 3, 4, 6, 7, and 10 are drawn at about the same scale. The size of the other figures has been regulated by convenience. The actual size of the larva is ·95 mm. or ·045 inch in length.

ON A METHOD OF PREPARING STEREO-PHOTOMICROGRAPHS.

By A. C. Banfield.

(*Read October 26th*, 1909.)

Plates 37–40.

In the paper which I now have the honour of presenting to you I wish to draw your attention—at least those of you who are photographers—to the singularly beautiful results which are obtained by applying stereoscopic methods to photomicrography, results which, in possessing the third dimension of depth, or distance, tell us more of the actual shape of an object in a single glance than is possible by any monocular photograph, however good.

Let us briefly dwell on the nature of a stereoscopic photograph, and understand why it is that two apparently similar photographs of a given object should give us such a wonderful sense of relief when examined through a stereoscope. I say apparently similar, for a difference exists between the two pictures, in most cases so small as to be imperceptible when viewed by the unassisted eye, but it is nevertheless there, and it is this minute difference which the brain recognises when the two photographs are viewed by the instrument which we know under the name of the stereoscope.

The dissimilarity of the two pictures is that which is caused by each of our eyes receiving a different impression of an object, due to their angular separation. It is entirely due to the separation of our eyes that we are enabled so readily to locate the position of an object in space with reference to others.

Turning now to practical methods, stereoscopic photographs of ordinary objects, views, etc., are taken by means of two separate cameras, for convenience mounted parallel to each

other on the same baseboard. Each camera has its own lens, the two lenses thus for photographic purposes replacing the human eyes.

I will now touch upon a point which is highly necessary to secure correct stereoscopic relief—that of the separation of the two lenses by which the pictures are taken. It has long been the practice of the makers to supply stereoscopic cameras with the lenses fixed at a distance apart of about 80 mm., a distance which is absurd when we bear in mind that the average interocular distance is no more than 62 mm. I imagine that this excessive distance was adopted with the idea of getting large pictures into each half, forgetful of the fact that shorter-focus lenses would embrace the same view on a smaller scale and yet enable the correct separation of 62 mm. to be observed. The result of this excessive but usual separation is very apparent in the distorted and uncanny sense of relief experienced in looking at the "commercial" stereoscopic views which are on sale everywhere. I have also seen many stereo-photomicrographs in which the same fault is evident.

I have pointed out above the usual method of preparing stereoscopic photographs, but there is another way by which they can be made, though not with the same facility—that is, by the use of a single camera. At many photographic dealers' a small fitting can be obtained which is placed between the camera and the tripod top. It is a very simple arrangement, consisting of a small board sliding in a grooved guide fixed to the tripod top, the camera being fixed to the sliding board, to which an amount of movement is allowed equal to the usual erroneous ocular separation of 80 mm. In practice, a photograph is taken with the camera at one end of the slide; the plate is then changed and the camera moved to the other end, when the second picture is taken: the two photographs resulting of course correspond to the right and left eye view. Equally good results are obtained as in the two-camera method, but moving figures of course cannot be included in the photograph.

It is by an inversion of this latter method that I prepared the photographs which I have had the pleasure of showing at this Club; but before describing my method in detail, we might consider the mathematical principles involved. As I have already mentioned, we may accept the average interocular

distance as 62 mm. and this distance furnishes us with a basis for practical work, as the quotient obtained by dividing this distance by the desired magnification gives us the correct separation of the lenses for that particular magnification. Thus if we are photographing an object × 62, then our objectives must be separated by 1 mm ; if × 31, then the separation must be 2 mm. This rule holds good whatever type of objective we use and at whatever magnification. If we wish to obtain a correct stereoscopic representation of our object at 1,000 diameters, the objective separation becomes 62 micra.

This consideration brings us at once to the root of the subject, as it is at once realised that no objectives yet made could be placed as close together as 1 mm. We might possibly get them, say, 10 mm. in diameter and by mounting them close together we could then work to × 6, but a system such as this would be far too inelastic for all-round work; we should occasionally want to take photographs at much higher and also lower magnification than this, so we must seek other means to fulfil our purpose.

Let us turn to the single-camera method referred to above. This we at once find suitable in every respect. We have only one lens to consider, which, although rendering two separate exposures necessary, enables us to work at any magnification we wish.

It is of course impracticable to move a long and heavy camera, such as is necessary in photomicro work, the often minute distance required for the objective separation, but it is very easy to move the object which we wish to photograph any required distance, great or small, by suitable mechanical arrangement.

I will now describe in detail the apparatus which I have used. It consists of two of the well-known Zeiss optical benches, mounted on trestles. For very low magnification (to about × 10) one only is used; for higher magnification than this they are placed end to end. I may remark here, in parenthesis, on the exceeding usefulness of these optical benches. There is indeed no optical experiment that cannot be performed on them.

At one end of the bench is fixed the lamp casing, the bench itself carrying the condensers, object stage, lens and camera, all of them adjustable in any position on the bench. The camera itself is a very simple affair, adapted for the English standard

stereoscopic size, $6\frac{3}{4} \times 3\frac{1}{4}$ inches. The formula I have mentioned with regard to the objective separation resolves itself in practice into two parallel lines drawn on the focusing-screen 62 mm. apart, by means of the stage. The object is moved till one of the lines cuts the image centrally, and the first exposure made ; it is then transferred to the other line, when a second exposure will give us our truly stereoscopic pair.

The lenses which I prefer for the low-power work which appeals peculiarly to me are the wonderful little photo-objectives sold by Zeiss under the name of the "Planars." They are perfectly corrected, and, as their name implies, their field is very flat—a very great advantage when the object is displaced from one side to the other of the field as I have explained. Their only disadvantage is that their aperture is so low that they cannot be used for high magnifications; when used at the full aperture of F 4, the limit is about 72 diameters, at which diffraction effects appear. The two which I have are of 20 and 35 mm. focus. I have also an objective of a similar type, of 42 mm. focus, made by Leitz, the performance of which is in every way admirable. It is very useful for such comparatively large objects as Mycetozoa, Foraminifera, etc.

With regard to the illuminating of the object I much prefer incident light. All the stereo-micrographs I have seen of objects taken by transmitted light seem to me to be very unsatisfactory, through diffraction and shadow effects. An object to photograph well from a stereoscopic point of view should be full of detail in every part. I believe that some very beautiful high-power photographs could be made of diatoms or similar objects by using a vertical illuminator. The exposures would be very long, but I live in hopes of trying something in this direction before long.

With regard to an illuminant, I have found the Nernst electric lamp with a one-ampere filament most suitable; incandescent gas is also very good, but the exposures become very long when the magnification gets rather high. As it is necessary that each picture should have an identical exposure, a time of the day must be chosen when the pressure is steady. About midday and nine in the evening are most suitable in this respect. I have also tried limelight and the open arc. With limelight it is very difficult to get equalised exposures ; pitting of the lime generally gives trouble in the middle of an exposure. The open arc is beyond most

people's resources, but it enables some very rapid exposures to be made. Using an open arc, with a current of 50 amperes, I have made a fully exposed negative of some aecidia on a nettle leaf × 67 with an exposure of 2 seconds. In spite of a deep cooling-chamber, one stands a great chance of burning a specimen with such a powerful light, unless great care is used. It is a great help to have a powerful arc when dealing with autochromes.

I should like to say a few words about autochromes. It is a matter of regret that these wonderful plates do not appear to be suitable for stereoscopic work. The trouble is not so much in the length of exposure as in their patchiness. It is impossible, in practice, to mix the starch-grains, of which the tri-colour filter is composed, in accordance with theoretical requirements. A number of grains of the same colour will persistently adhere to each other, these forming distinct colour blotches, which float in space over the picture proper when seen in the stereoscope.

As photomicrographic work is usually done with an artificial source of light, the usual autochrome filter is unsuitable. A special filter is made for the electric arc, which I have not used with any great success. It is doubtless correct for a certain composition of the carbons; but these are continually varying, creating small differences in the colour composition of the light to which these plates are exceedingly sensitive.

A very good method of working is to convert the light from a Nernst lamp to theoretical daylight by a special blue filter made for the purpose, and then use the usual daylight filter. This necessitates very long exposures; but the results are well worth the extra trouble involved, as the colour rendering is as accurate as one could possibly wish.

Description of Plates.

Plate 37.

a. Lamp casing containing hand-feed arc lamp.
b. Lens to parallelise rays from arc.
c. Water-cooling chamber.
d. Long-focus lens, converging the parallel rays, after reflecting from mirror *h*, on the object *o*.
e. Short-focus lens.

f. Plano-concave lens to parallelise the converging rays from *e*. This gives a parallel beam of small diameter, but of great intensity.

g. Object stage laterally adjustable by means of the vertical pinion.

h. Small mirror universally adjustable.

i. 35 mm. lens (Zeiss Planar).

j. Focusing pinion.

k. Camera.

l. Optical bench, on which the whole of the above is adjustable. The optical axis of the condensing system is 52 mm. above that of the camera. The horizontal line shows the course of the central ray of light. The condensers *d* and *e* are mounted on a hinged fitting, the one not in use being folded down out of the path of the rays.

Plate 38.

Mycetozoa (*Physarum nutans*), × 12.

Plate 39.

Peristome of moss (*Mnium undulatum*), × 29.

Plate 40.

Skeleton of young Star-fish (*Asterias glacialis*), × 7.

ON THE GEOGRAPHICAL DISTRIBUTION OF THE ROTIFERA.*

By Charles F. Rousselet, F.R.M.S., Delegate of the Club.

(A paper read before the Zoological Section of the British Association at Winnipeg, in August, 1909.)

The results of recent investigations point more and more to the fact that the Rotifera enjoy a cosmopolitan distribution which is not limited to continents, but extends to all places on the surface of the earth where suitable conditions prevail. Wherever search has extended in Europe, America, Africa, India, China, Australia, and even the North and South Polar regions, the same genera and even species have been met with, and it is not possible to speak of any typical or peculiar Rotatorian fauna for any continent, zone or region.

It is true that some species have so far been found in one locality only, but that must be attributed to the fact that no country has as yet been thoroughly explored. The greatest number of species are known from Europe, and in particular from England, evidently due to the fact that in this country the greatest number of searchers have been at work on this group.

In the United States the Great Lakes have been explored by Jennings, and the Illinois River by Prof. Kofoid, and some few other regions by Kellicot, Hempel, and others; but though about 300 species have been recorded, no very peculiar and distinctive American forms have been revealed.

In Canada, unfortunately, no one has yet been found to take

* An abstract of this paper will in due course appear in the Report of the British Association for 1909.

up their study, and the Rotatorian fauna of the Dominion therefore remain quite unknown.

From South America eighty species have been recorded by Prof. von Daday, in plankton collections made in Paraguay, of which three only are described as new, all the others being already known in Europe.

During the British Association meeting in South Africa in 1905, I myself collected in various widely separated localities —Capetown, Orange River Colony, Transvaal, and Rhodesia— in all 63 species, all of which except one were already known in other parts of the world. Even in the Zambesi River, where I obtained 38 species in pools just above the Victoria Falls, all of them without exception were already known outside Africa. Gunson Thorpe, W. Milne, Thomas Kirkman, and James Murray have recorded about 100 more species from other parts of South Africa, of which less than half a dozen were new forms.

From Central Africa I have examined collections made by Dr. W. A. Cunnington in Lake Tanganyika and adjacent rivers; and though this material was very poor in Rotifera, I obtained about 40 species, all known already in Europe.

In moss collected in the Sikkim Himalaya in India Mr. James Murray observed 36 species, mostly Bdelloids, of which 5 only were as yet unknown in Europe.

As regards distribution in Arctic and Antarctic regions, I may mention that Dr. Bergendal has recorded 82 species, belonging to 38 genera, from Greenland, where the pools and shallow lakes are frozen, often to the bottom, for eight months in the year. With the exception of a few new species found there for the first time, all these forms belong to the ordinary European fauna.

In collections from two lakes in Iceland, Dr. Wesenberg-Lund found 9 species of Rotifers, all having a wide distribution in Europe.

From Ross Island, in the Antarctic continent, Mr. James

Murray has quite lately brought back evidence of a considerable Rotatorian fauna, mostly Bdelloids, which he found living in large patches at the bottom and also on the surface of shallow lakes formed during the short summer period; most of these are common forms in Europe, Africa, India, and elsewhere, but a few will be described as new species. During the cold weather these Bdelloids contract into little balls and are frozen solid, but revive immediately the ice melts. Amongst the other species *Hydatina senta* was found in abundance in one of the lakes on Ross Island.

The very erratic appearance of rare or uncommon species in widely separated places seems to show that distance is no obstacle to their distribution, provided only that they find suitable conditions. A few examples of such erratic distribution may here be cited:

Trochosphaera aequatorialis was found by Semper in ditches which intersect ricefields in the Philippine Islands in 1859; its next appearance was in 1889 in Australia, where Gunson Thorpe found this same spherical Rotifer in a pond of the Botanic Gardens in Brisbane; a year ago it was once more found by Mr. Colledge near the same locality.

Trochosphaera solstitialis was first discovered in 1882 by Gunson Thorpe in irrigation creeks near Wuhu in China, some 260 miles up the Yangtse-Kiang; four years later the same species was found by Prof. Kofoid in the Illinóis River, and also by Prof. H. G. Jennings in a pool close to Lake Erie in America.

Tetramastix opoliensis, first discovered by Prof. Zacharias in 1897 in water from the Oder near Oppeln, in Germany, was found by me four years ago in a pool in the Matoppos, Rhodesia; then it was obtained in Bohemia by Hlava, and lately in France by Dr. de Beauchamp.

Lacinularia natans, a free-swimming form, was first found by Mr. Geo. Western at Shepperton, near London; and some years later in Victoria, Australia, by John Shephard, and not since.

Lacinularia elliptica was first discovered in Australia by

Mr. Shephard, and afterwards found by me in Rhodesia between Bulawayo and the Victoria Falls.

Megalotrocha semibullata was first found by Gunson Thorpe at Brisbane, Australia, then recorded in New Guinea, then in Switzerland by Dr. Weber, then in Natal by Hon. Thos. Kirkman.

Megalotrocha spinosa was first discovered in China by Gunson Thorpe, was then found in Switzerland by Dr. Weber, then by myself at a station near Gwaai in Rhodesia, and lately in Paraguay by Prof. von Daday.

Conochiloides natans was first obtained by Dr. Seligo in the Stuhmer Lakes in Germany, afterwards near Ploen by Voigt, then in Bohemia by Hlava, and finally by myself in a railway water tank at Norton Station, Mashonaland.

Notops brachionus var. *spinosus*. In 1900 Mr. Thomas sent me some dried mud from the bottom of a dried-up pool in Rhodesia. I placed this in water, and after a few days this Rotifer, then new, was hatched from some resting egg, and came to life in my tank. A short time afterwards specimens of this same species were sent to me by Hon. Thos. Kirkman from Natal, and quite recently it has been found near Sofia in Bulgaria by Dr. Consuloff.

Ploesoma lenticulare was first found in Lake Erie, in America, by Vorce and Herrick, then in Sweden by Jägerskiold, in Galicia by Wierzejsky, in Finland by Levander and Stenroos, in Ireland by J. Hood, and by myself in a railway water tank in Rhodesia.

Pedalion mirum was first found in 1871 near Clifton, in England, by Dr. Hudson, then in numerous places all over England; also in Germany, Finland, Switzerland, United States. It is also recorded by Gunson Thorpe from a rock pool on Dunk Island, off Queensland, Australia, and in a pool formed in a hollow tree in Fiji, and finally by myself in a streamlet in the Matoppos, Rhodesia.

These examples of the occurrence of rare species of Rotifera in widely separated and distant lands will suffice to show the ex-

treme range of distribution which these very minute but highly organised animals have attained, and this in spite of the fact that they are essentially fresh-water forms, and that the sea is to them an impassable barrier.

As regards temperature it appears that though the majority prefer a moderate degree of heat, there are many species which live equally well in cold Arctic and alpine lakes, where the temperature is only a few degrees above freezing-point, and in the warm lakes of tropical countries. But there is no doubt also that some species are able, slowly no doubt, to accommodate themselves to much higher temperatures, and Dr. R. Issel has found ten species, ordinary kinds, living in hot springs near Padua in Italy, at temperatures ranging between thirty-five and forty-five degrees centigrade.

On the other hand, in Arctic regions, where all water becomes solid during the greater part of the year, the Rotifers, or their eggs, survive the most severe frost, and come to life again as soon as the ice melts. Mr. James Murray informs me that in the Antarctic regions he found at the bottom of a lake on Ross Island, which had been frozen solid for an unknown number of years, a layer of mud containing frozen Bdelloid Rotifers, which recovered and came to life immediately they were placed in water. In order to reach this bottom layer Mr. Murray had to make a shaft fifteen feet deep through solid ice. This, I think, constitutes a record of endurance for Rotifera.

To account for such a distribution over the whole of the globe it has been supposed that most species of Rotifera can be dried up, and their bodies carried by the wind, as dust, for long distances, and then come to life again on landing in suitable surroundings. This is, however, a very erroneous generalisation of the fact that a very few species of Bdelloid Rotifera, and in particular *Philodina roseola*, as first shown by Davis, are capable of secreting, when drying slowly, a gelatinous envelope in which they can resist drought for many months, and come to life again on being placed in water. This property appears to be confined

to the above species and some moss-haunting Rotifers of the genera *Philodina* and *Callidina*, which habitually live on moss that periodically dries up and then becomes wet again by rain. Species living in always submerged moss do not appear to acquire this property. Another condition of the formation of the protecting gelatinous envelope is that the desiccation should be slow, otherwise it cannot be formed, and the animals die in a short time.

My experience has shown me, and is confirmed by the experiments of D. D. Whitney, that the vast majority of Rotifers die immediately on being dried, and do not revive after complete desiccation; but their eggs, and in particular their resting eggs with more resisting shells, can stand a prolonged state of desiccation and also freezing, and can therefore readily be transported by the wind, or by aquatic birds and other animals, and will hatch when deposited in suitable pools of water.

In my opinion it is by this means that the cosmopolitan distribution of the Rotifera over the world has in the course of time been mainly brought about.

The total number of known species of Rotifera may at present be estimated at about 825. In Hudson and Gosse's Monograph of 1886–9, 400 species were described; since that time 527 new species have been named, of which, however, quite a hundred may be deducted as synonyms, or as very doubtful.

NOTE ON A QUICK METHOD OF PREPARING AND STAINING POLLEN.

By W. Wesché, F.R.M.S.

(Read October 26th, 1909.)

After trying staining the grains and clearing them in phenol and xylol, which failed to remove the stain and also presented great difficulties in manipulation, I tried the following quick method, which answered admirably.

The flowers were collected during the period August 1st–15th; they were kept in pill boxes till October 2nd, when the experiment was made.* They were shaken on to a slip and scraped with a needle to free the pollen; the débris other than pollen was removed with forceps, using the dissecting microscope. The pollen was scraped into a heap on the centre of the slip and stained with methylated spirit in which a few granules of methyl violet had been dissolved. This stain must not be too dark; it should be quite transparent, though violet in colour. This process lasts about a minute, several drops being added at intervals, and the slip is then placed on the hot plate. In the next process watch carefully to see that the liquid is in every case not completely evaporated. At the psychological moment add a drop of unstained spirit; repeat this, then add a drop of turpentine; repeat this three times, add a drop of balsam and xylol, and cover with the thin glass. The cover-glass should be placed on the edge of the slip, so as to be at the same temperature when it is placed on the balsam, and it is then less likely to hold air bubbles. The slip will be dirty with stain and turpentine; this can be removed when the slide is cold with a rag dipped in spirit.

N.B.—When the cover-glass is on, extinguish the lamp, and let the slide cool with the hot plate.

* Later on perfectly fresh pollen was experimented with, and found to be equally good, so that it appears unnecessary to dry it. One of the Compositae was used, stained with fuchsin—a granule in methylated spirit.

NOTE ON BEETLES ON TURKISH TOBACCO LEAF.

By J. P. Wright.

Read October 26th, 1909.

Infested leaf was given to me by an expert in the tobacco trade, and from him I gathered the following particulars.

Turkish tobacco leaf is imported in bales, fairly compressed. When an infested bale is opened few mature beetles are observed, but when the leaves are separated they soon make their appearance. Given an infested bale, the eggs, and subsequently the adult insects, are plentiful, but the larval and pupal stages are scarce, or, rather, are difficult to discover, as of course they must be there. The metamorphosis of a beetle takes some considerable time, and it seems to me somewhat strange that the intermediate stages are not more readily discoverable. In one slide in my possession there appears to be a cocoon, but it is possible that this may have been formed by some insect other than the beetle in question. My informant tells me—I use his own words—the beetles thrive merrily on Naphthaline. As an experiment, some of the infested leaf was put in a box with a perforated false bottom, in which was put some Naphthaline, and so left for some time. When the box was opened it was found that the beetles had left the leaf and taken refuge in the Naphthaline, from which, however, they flew in clouds as soon as the cover was removed.

Bisulphide of carbon effectually disposes of them.

These beetles are not found on Indian, African, Virginian, or China leaf, but seem peculiar to the Turkish growth, and it is only an occasional bale of this kind that is so infested.

NOTE ON THE MOUNTING OF SPIDER DISSECTIONS AS MICROSCOPICAL OBJECTS.

By Frank P. Smith.

(*Read November 23rd*, 1909.)

Cognisant as I am that my usual reply to inquiries concerning my methods of mounting spiders has been for years past to the effect that I do not mount them at all, I am rather diffident in offering these few hints as to a means whereby slides may be prepared in which the form and structure of the objects concerned are faithfully preserved and exhibited.

I must insist, at the outset, that to attempt to "clear" a spider with liquor potassae or any similar reagent is promptly to ruin it as far as systematic work is concerned. The integuments of the body are generally very deficient in chitin, and become hopelessly transparent when treated with an alkali, whilst the male palpus, whose form is of paramount importance in the identification of species, is almost invariably distorted by any attempt at "clearing." Apart from alkaline treatment, any pressure of the cover-glass must be regarded as fatal.

The chief use to which the arachnologist would put mounted preparations would be comparison with other and usually unmounted specimens. For this reason it is obvious that every endeavour must be made to preserve the mounted dissection in as nearly as possible the same condition as the unmounted object. It often happens that one possesses a solitary example of a rare and obscure spider, and may have occasion to compare it, time after time, with specimens more recently captured, or received from correspondents. This means, under ordinary conditions, the removal of the specimen from its tube of spirit, with much consequent damage to legs and spines, all the more so on account of the manipulation required to place it in the proper position for observation in the saucer of spirit in which it is usual to examine these creatures. The mounting of such a specimen, or of some important portion of it, upon the orthodox 3 × 1 inch slip is clearly an advantage provided that (1) it can be so mounted as not to disturb the relative position of its component parts or alter their form, (2) that it can be mounted permanently, or, if not, that it can be expected to keep in good condition for a reasonably

long period, and that it can, should the mount deteriorate, be remounted without more trouble or risk than that involved in the original process. In giving details as to how I usually prepare such mounts I should like it to be understood that I lay no claim to the method being anything revolutionary or novel; and I trust that my endeavour to make the process intelligible to the tyro may be accepted with forbearance by the expert. We will presume that a palpus of a male spider is to be mounted—say for example that of the "garden spider" (*Araneus diadematus*). The procedure is as follows.

The spider when caught is killed by immersion in whisky. Some one will probably ask, "Why not brandy?" There is no reason except that when I commenced this work there happened to be a bottle of whisky in the house and I purloined sufficient for my first experiments. Finding it successful, I continued to use it. Throughout these remarks it should be understood that in almost every detail of the process now recommended numerous variations in procedure might be proposed, often, perhaps, with advantage. I merely suggest that the beginner should mount a slide or two blindly following the instructions, and then work out improvements for himself.

If a preserved spider is to be dealt with, we remove the palpus and soak it in whisky for an hour or so—this is, of course, presuming that the specimen has been suitably preserved in methylated spirit. We also obtain some glass slips with circular cells about $\frac{1}{2}$ in. in diameter excavated in them, some tin cells of $\frac{3}{4}$ in. diameter and of various thicknesses, and cover-glasses to match. The cells should be ground perfectly flat (not polished) upon each side. This is easily accomplished by gluing a sheet of emery cloth upon a smooth board, and rubbing the cell upon it by means of a large cork or flat piece of india-rubber. Some of the thicker cells should be ground down to various degrees, for reasons which will appear later. The slips must be scrupulously clean. Should they be at all greasy a little liquor potassae will be found useful.*

* Mr. A. W. Sheppard tells me that a mixture of bichromate of potash and sulphuric acid is the most perfect medium for cleaning glass. The importance of theoretical cleanliness in work where the adhesion of cement is a primary consideration cannot be overestimated. A piece of gelatine-coated paper, which will stick like a limpet if placed wet upon perfectly clean glass will, as every photographer knows, peel off the glass with the utmost ease if the slightest trace of grease or even French chalk has been applied.

The following reagents, which should be brought to exactly the proper consistency for easy working by the addition of their respective diluents, will be required: Gold-size, caoutchouc cement (Millar's), and Club black. As a mounting medium mix equal parts of whisky and glycerine. This should be carefully filtered, or else allowed to stand for a few days and decanted.

Place a slip on the turn-table, and run upon it a ring of gold-size $\frac{3}{4}$ in. in diameter. Take a cell, and, by means of a pair of forceps, drop it on to the ring of gold-size, pressing down to ensure good contact. Prepare a number of these slips, using cells of different depths, and put them aside for a week to dry. Do not forget that as excavated slips are being used, a larger proportion of thin cells will be required, unless very large objects are to be mounted. If any considerable amount of work of this kind is contemplated, some means of judging the relative thickness of cells will be useful—for example, a piece of brass with slots of different widths in it.

Take the whisky-soaked palpus and place it in one of the deepest cells, fill up with whisky, and place a temporary cover-glass upon it, holding it in position by means of a wire-clip. Now turn the slide about, and observe what happens. If the cell is very deep compared with the thickness of the object, this latter will fall to the side. If somewhat shallower, the object will only reach the margin, or near to the margin, of the now practically invisible excavation in the slip. Try cells of various depths until the one is found which will produce the desired result, which may be to keep the object perfectly still, or else to allow it a certain amount of movement. Minute dissections may be mounted in the excavation without the use of a tin cell at all.

The proper slip having been found, it is thoroughly cleaned, placed upon the turn-table, and a ring of caoutchouc cement run upon the upper surface only of the tin cell. This is allowed to remain for (say) a quarter of an hour, until it can just be gently touched with the finger without adhering. The cell is then filled to overflowing with the glycerine and spirit mixture, the dissection is introduced and arranged, and a cover-glass put on, and held in position with a weak wire-clip. The whole is now held under a gentle stream of water from a tap, in order to get rid of every trace of the glycerine from the glass. The whole success of the process depends upon this being thoroughly accomplished.

The removal of the clip is something of a problem. In almost every case a bubble of air will rush in unless a special precaution is taken to avoid it. This is exceedingly simple to accomplish—so simple, in fact, that it escaped my attention for a considerable time and lured me into many fruitless experiments with far more elaborate methods. The clip is simply removed under water and the slide allowed to remain submerged for a few minutes. A small quantity of water will enter, but this will not in the least impair the mounting medium. The clip is then wiped as far as possible, allowed to dry thoroughly, a ring of gold-size is added and, a couple of days afterwards, a ring of Club black. The object can be examined at once with dark-ground illumination, but generally improves after a few days when the glycerine has thoroughly penetrated it.

Probably some one will point out the advisability of doctoring the gold-size with white lead, red lead, litharge, or some other metallic salt, or will dilate upon the advantages of putting on seven rings of gold-size and seven rings of Club black alternately at intervals of fifteen days. Probably there is wisdom in these suggestions; but the method here advocated has at least the advantage of simplicity, besides being expeditious, matters of great importance to a man who needs to prepare large series of slides for research work. I might mention that I have a considerable number of such preparations dating back for more than two years, and that in no single instance has an air-bubble penetrated in spite of a good deal of very rough usage. Experts wag their heads wisely and tell me they cannot last must longer; but even if this is so I consider they have already more than repaid the trouble taken to prepare them.

Talking of air-bubbles, some one will assuredly remark that it is a good plan to "put a bubble in the mount" as a safety-valve for heat expansion. This may be so. Personally I detest a bubble in a mount, especially in the case of a spider palpus, for sooner or later a fragment of its spherical nothingness is almost sure to become entangled with the complex structures of the object and interfere with critical examination. The theory of the safety-valve is, however, worth bearing in mind, if only as an excuse for the presence in a cell of a refractory bubble which defied the mounter in his efforts to exterminate it.

A NEW WORK ON MICROSCOPY.

Practical Microscopy: An Introduction to Microscopical Methods. By F. Shillington Scales, M.A., B.Ch. (Cantab.), Curator R.M.S. $4\frac{3}{4} \times 7$ in., 334 pages, with 122 figures in the text. London, 1909. Baillière, Tindall, & Cox. 5*s*. net.

Three years ago we had the pleasure of reviewing in this Journal a work entitled *Elementary Microscopy*, which we unhesitatingly recommended to the beginner. We quite expected, at the time, that a second edition would be called for at no very distant date; but we must admit that we are genuinely surprised at the form which it has taken, for with its new title and greatly augmented contents it is hardly recognisable.

Candidly, we do not consider this a book which ought to "find a place on the bookshelves" of the up-to-date microscopist. Its proper situation is on his working-table, or in his pocket—anywhere, in fact, where it will be the first thing to attract his attention when on the look-out for information concerning his work.

The author is obviously in deadly earnest in his very successful endeavours to impart information. The chapter on microscopical technique might perhaps be calculated to frighten the beginner, as it is replete with laboratory methods of fixing, staining, and section-cutting, both at the beginning and at the end. He will find, however, secreted somewhere near the middle all that he is likely to want to know about the simpler methods of mounting.

The chapter dealing with the practical optics of the microscope is a masterly and eminently successful attempt to lucidly explain a number of problems with which the student is confronted.

Several interesting modern discoveries, too, are dealt with, notably the use of ultra-violet light rays in photomicrographic work.

We have seen many works on microscopy, pretentious, elaborate, gorgeously illustrated, and admirable in many ways, but never such a *multum in parvo* of all that the average microscopist desires to know put forward in such a concise, intelligible, and practical manner.

F. P. S.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on January 1st, 1909, Prof. E. A. Minchin, M.A., President, in the Chair, the minutes of the meeting held on December 4th, 1908, were read and confirmed.

Messrs. H. C. Leadbeater and F. H. Dodd were balloted for and duly elected members of the Club.

Numerous additions to the Library were announced, and the thanks of the Club voted to the donors.

Messrs. Watson exhibited a new form of portable microscope —the "Club" model. This was described, for the firm, by Mr. F. W. Watson Baker, F.R.M.S. It is claimed that it is sufficiently strong in construction to bear constant travelling and heavy use, and is rigid, compact, and thoroughly efficient. The design does not require the taking away of any piece when folding up. The legs fold backwards around the limb, and the mirror tailpiece pushes up through the stage. The stiff leather case into which it packs, with space for eyepieces and objectives, measures $7\frac{3}{4}$ in. by $3\frac{3}{8}$ in. by $4\frac{1}{2}$ in. Coarse and fine adjustments are fitted, the former giving sufficient range for a 3-in. objective; the latter is a direct-acting micrometer-screw. A draw-tube is supplied, and the under-stage fitting is of standard size.

The list of nominations by the committee of officers of the Club for the ensuing session was read, and nominations for other members of the committee were taken.

Mr. A. Earland gave an account of his exhibition, then before the meeting, of Arenaceous Foraminifera, illustrating their selective power. In his introductory remarks the speaker said that the exhibition might claim attention not only for the objects, but

also for the instruments under which they were shown. Such an assemblage—some twenty-five or so—of that rapidly disappearing instrument the binocular microscope as was presented that evening is nowadays seldom to be seen; and as the specimens were of such a nature that they could not be seen to best advantage under any other form of instrument, Mr. Earland said his thanks were all the more due to Mr. Charles Curties for the courtesy with which he had assisted in the provision of so many of the instruments used. Thanks were also due to other friends who had assisted by setting up the specimens exhibited. The majority of the objects on exhibition were selected from the speaker's own dredgings taken in the North Sea and North Atlantic during the last year or two, and they were all chosen with the view to illustrating the great diversity of structure and technical skill exhibited by Arenaceous Foraminifera—that is, by the forams which have composite tests or shells. Many of the specimens had already been exhibited at the Club on different occasions following their finding; but as the majority were objects such as were not to be seen every day by microscopists unless specialists in this branch, it was thought that the preparations would all bear a second examination.

For the benefit of those present who might have but a limited acquaintance with the order, the lecturer made a few general remarks dealing with the subject. He said that the Foraminifera are very generally divided into three groups, distinguishable by the appearance and structure of their shell-wall. The three groups are: the Imperforate or Porcellanous, the Arenaceous or Composite, and the Perforate or Hyaline. Of these, the first corresponds to the family Miliolidae of Brady—this being the classification generally accepted. The second corresponds, on the whole, with the families Astrorhizidae and Lituolidae of Brady; and the third, the Perforate or Hyaline group, includes all other forms—*i.e.* the families Textularidae, Chilostomellidae, Lagenidae, Globigerinidae, Rotalidae, and Nummulinidae. It may be mentioned that, while the Arenaceous group corresponds, on the whole, with Brady's two families Astrorhizidae and Lituolidae, there are certain members of both the other divisions which assume an arenaceous test. These, however, are exceptional species, and for purposes of general classification may be disregarded.

Having regard to the extremely limited powers of locomotion in the Foraminifera, it is obvious that those species which form a shell or covering of adventitious matter, instead of secreting one by chemical processes from the sea-water, can only do so by utilising the material on the spot. Hence it might, perhaps, be thought that there would exist great similarity between different forms living on the same spot and under identical conditions. But such is not the case, for nearly every species has well-marked characteristics which serve to distinguish its test from those of closely allied forms, and nearly all possess some mysterious power of selecting material which leads to the most striking results, and which, when considered in relation to the extremely low organisation of these animals, can only be regarded as wonderful. Thus one form will utilise nothing but large grains of sand, which are cemented together very roughly and without any attempt at symmetry; another species utilising grains of the same size will lay them side by side with such neatness as to form a sphere of practically smooth surface; a third will reject all large grains of sand, and build with nothing but the finest grains; while yet another, rejecting sand altogether, will utilise the almost impalpable mud, and plaster it over a chitinous membrane as support. Other species show a marked predilection for sponge spicules, which are always present in greater or less abundance in marine muds, and, selecting these, cement them side by side to form a thin shell-wall, or felt them together with fine sand and mud for the same purpose. To grasp fully the significance of such a marvel of construction as is presented by the shell of a Technitella (the term meaning "little workman," and, the lecturer thought, well named), one must remember that the animal which formed it was but a tiny particle of protoplasm with a nucleus, and had no organs of any kind, whether alimentary, muscular, or nervous. Mr. Earland said that when showing such specimens he had often been confronted with the remark, "Oh! that is nothing very wonderful; the Caddis larva can do as much as that," or "Melicerta can build a tube better than that." This, of course, was quite true; but the Caddis larva and Melicerta are, in organisation and structure, as far above the Foraminifera as man is above them. Knowing their complex structure and organs, we need not admire their work any the less if we admit that the Rhizopod, without organs of any kind, can outbuild them all.

The lecturer then proceeded to describe at some length the more important of the preparations exhibited. The first slide was a general group, selected from different parts of the world and from various depths, intended to show the great variety of texture and neatness displayed in the building of the test by the Arenaceous Foraminifera. There was a tolerably complete series, ranging between (1) species in which the particles of building material were simply piled together without much order or definite arrangement, through (2) other species in which the separate particles of building material were visible, but with the joints neatly filled and "pointed" with cement, to (3) species in which the particles used were so large that the bricks were lost in the mortar, so to speak, and a smooth, homogeneous surface resulted. The cement used by Arenaceous Foraminifera is of two kinds—chitinous and ferruginous. The chitinous cement is usually only visible as a film on which the particles are cemented; but the ferruginous cement, owing to its colour, is one of the most striking features of the whole group.

In referring to another slide, it was said that the names of the Foraminifera, though cumbrous, are in most cases capable of translation, and often describe the object very neatly. The name of the one then under discussion, *Astrorhiza limnicola*, meant "the star-shaped root dwelling in the mud." This form exercised practically no selective power, and used hardly any cement. The test was, therefore, very brittle, and was seldom found perfect in dried material. In referring to another form, *Crithionina pisum*, Göes. (= barley-like pea), the speaker said that he thought the name of this little organism was not altogether a happy one. He had puzzled for some time over the propriety of naming a light-grey sphere "barley-like," until he thought of the solution—pearl-barley. It was suggested that the learned Swede who coined the name was most familiar with barley in this form. Specimens of this species are sometimes found which have been perforated by some small boring mollusc. *Psammosphaera fusca* (= dark sandy sphere), one of the commonest of the North Sea forms, is, perhaps, the lowest of all as regards selective power. The shell, although always approximately spherical, is very roughly made, sand-grains of all sizes being employed. When no sand is available, as in the deep sea, the animal collects the shells of other Foraminifera, living or

dead, and builds its test from these. The only inconvenience to a living "foram" so attached would probably be that part of its feeding area was cut off. Among many other interesting forms referred to was a new and at present undescribed species of Technitella from the North Sea, which represented the highest development of selective power in the Foraminifera. The test is built up entirely of perforated calcareous plates from Echinoderms (probably from Brittle Stars). Much ingenuity is displayed in closing the ends of the cylindrical shell with a bunch of plates of different sizes. There appears to be no definite aperture, and such would hardly be necessary, as the plates are perforated. It may be remarked that these calcareous plates are very rare, and one would have to pick over many trays of mud-washings to get, say, even a dozen such plates. But this little animal rejects all other material in building. In concluding his remarks Mr. Earland referred to the triple isomorphism between Arenaceous, Imperforate, and Perforate Foraminifera of certain species, and was of the opinion that it proved that the present system of classification was entirely artificial.

Some considerable discussion ensued, in which the President, Secretary, and Messrs. Scourfield and Hilton took part, and to which Mr. Earland replied.

At the meeting of the Club held on February 5th, 1909, the Right Hon. Sir Ford North, F.R.S., Vice-President, in the Chair, the minutes of the meeting held on January 1st were read and confirmed. Messrs. W. Hebdon and J. A. Beresford were balloted for and duly elected members of the Club.

Mr. F. W. Watson Baker, F.R.M.S. (for Messrs. W. Watson & Sons, Ltd.), gave a most interesting demonstration on "The Making of a Microscope Objective." The chief items of interest were: Examples of optical glass—flint and crown, with pieces "slit" ready for working; a light form of optical-worker's lathe, at which the preliminary stages in the production of a lens—edging, shaping, and rough-grinding—were carried out. At a further stand the final figuring and polishing of a high-power front lens were demonstrated. Some very beautiful examples of proof-

plates and "flats," exhibiting Newton's rings, were also shown. For the further benefit of members, Mr. Watson Baker had provided a short "Explanation of the Demonstration" in the form of a specially printed leaflet, from which we extract the following: "The successful production of a microscope objective is dependent on (1) the mathematician, (2) the tools, (3) the workman, (4) the mounter. The mathematician so computes an objective that, when it is constructed from the optical glasses which he has chosen as suitable for their refractive and dispersive qualities, with the component lenses shaped to the thickness and curvature he has prescribed, and finally mounted and accurately centred at the computed distances, it will exactly realise his intentions. The glass being selected, convex and concave templets or gauges are made of the radii of the various constituent parts, and pairs of tools turned to fit the curvature of the gauges. These tools are divided into roughers, true-tools, and polishers. From the glassworks the glass is received in thick slabs or plates, and by means of a slitting-machine, consisting of a rapidly rotating iron plate charged with diamond-dust and oil, thin plates are cut off to approximately the thickness of the lens. These plates are then cut into small squares, and are trimmed nearly round with hand-shanks. The little rough disc of glass is then cemented with shellac to a holder, and rotated in a lathe, and, with a steel tool lubricated with water, is edged to within a fraction of its ultimate diameter. The next stage is to shape the face spherically. The lens in its rough state is then removed, in its holder, from the lathe, and the roughing tool takes its place. The lens, in its holder, is held in the hand; the lathe is rotated, and the lens is ground against the required tool; emery moistened with water is the abrasive agent employed. Polishing is then done with a tool lined with a composition consisting largely of pitch, rouge and putty-powder being among the polishing materials employed. From time to time the curve is tested by means of a 'proof-plate.' A 'proof-plate' is a plate of glass which has been worked so as to precisely fit the exact curve of the lens which it is intended to test by its means. If a carefully cleaned lens be brought into contact with the curve in the 'proof-plate,' and is nearly correct, there will be observed the phenomena known as Newton's Rings. These coloured rings are produced whenever two reflecting surfaces are brought very close together. These rings form an extremely

delicate test for the truth of lens surfaces, for, roughly speaking, the colours run through the complete range of the spectrum for every increase of the space between the adjoining surfaces of the lens and proof-plate by $\frac{1}{50000}$th part of an inch, and it is quite easy to detect irregularities in the surfaces of so small an amount as the $\frac{1}{1000000}$th part of an inch. When a lens is absolutely correct to the proof-plate, the appearance is that of one uniform tint of colour over the entire surface. In the final stages the lens is once more mounted on the lathe-spindle, to be centred. The various constituents are then cemented together and baked for several hours, are subsequently mounted in their brass fittings, and the adjustment for axial truth and distance completes the process."

In acknowledging a very hearty vote of thanks for the demonstration, Mr. Watson Baker said some people seemed to think that there was some occult influence in Jena glass. People would ask whether a given objective contained or was made of Schott or Jena glass, and, on being told that such was the case, would go away quite satisfied. Other people have the idea that any glass may be used, so long as it is properly ground and polished, and have no knowledge at all of the properties of Jena glass. In a catalogue issued in 1180 by an eminent firm of optical-glass makers only six kinds of glass are listed, and from these the optician's work had to be done. Then came the Jena glasses with their enormous possibilities. The Schott works now catalogued eighty varieties as regularly stocked, and of these varieties there are many variants—sometimes as many as a hundred of one kind. It is only by having at command such a variety of glasses that the modern objective has been made possible. Referring in more detail to the exhibits before the meeting, the speaker said that the old method of testing lenses in process of grinding was by using a templet of metal cut to the required curve, and it was left to the worker to decide whether or not the lens fitted. A modern objective represents the genius of the mathematician, the skill of the optical-glass maker, and of the mechanician and supervisor, all combined to produce the effect obtained.

Among the presentations made to the Club was a copy (presented by Dr. Spitta, President of the Club 1904–7) of the second edition of his valuable work on "Microscopy."

The forty-third annual report of the Committee was read by the Hon. Secretary, Mr. W. B. Stokes. During 1908 there had been a net gain of sixteen members, the total on December 31st being 469. The average attendance at the ordinary meetings was 95·9. A list of papers read, lectures and exhibitions given, and of new apparatus brought forward followed. Special thanks were expressed to the editor of *The English Mechanic* for the publication of lengthy reports of the meetings in the issue of the second Friday in the month.

The Hon. Treasurer, Mr. F. J. Perks, presented his report for the year 1908, showing a slightly increased balance in hand. The investments remain as in the previous year. He considered the financial position of the Club satisfactory.

The usual votes of thanks were made to the officers and members of committees for their services.

Dr. Duncan J. Reid, M.B., C.M., gave a lecture on "A Method of Estimating the Exposure required in Photomicrography with Axial Cone Illumination." He said that it was generally admitted that to obtain a perfect negative it was necessary that the exposure should be correct. In ordinary photography there are tables of many kinds, and various forms of actinometers, to help in the matter; and in photomicrography he had no doubt that every one has, as he used to have himself, some more or less reliable method of calculating what the exposure for a certain magnification, etc., should be; but until he had worked out the method about to be described he had not come across any systematic method of calculation. Dr. Bousfield had described a method of estimating exposures by the use of a sensitometer on the ground glass; but that appeared to be only suitable for low powers and for a lamp-flame. Reference was also made to a paper read on October 16th, 1907, before the Royal Microscopical Society by Dr. A. Letherby; but the lecturer thought that the details there given were insufficient. His own method was intended to give the exposure required to obtain a fully exposed negative with what might be called an average slide, under varying apertures and magnifications. The method also enables the conditions under which an exposure has been made to be recorded with such accuracy as to make it possible to repeat it under absolutely similar conditions. In photomicrography the same series of factors have to be taken

into account as in ordinary photography, and these were then considered. First, Magnification.—This factor may be dismissed with the remark that it increases the exposure in the direct ratio to the square of the magnification. Second, Light; and third, the Plate.—With these two factors we have in photomicrography the advantage that one usually keeps to the same source of light, and also usually the same plate. A series of exposures is made on a selected make of plate, with a certain light, and with the condensing apparatus (consisting of a Nelson lens and achromatic substage condenser) arranged so as to give critical illumination. A lantern-slide of a diatom was then thrown on the screen. The negative, which was taken at × 250 and with an aperture of 0·50 N.A., edge of kerosene-oil flame, had received a series of strip exposures ranging from two to twelve seconds. Of these Dr. Reid considered that either six or eight seconds gave the best result, and took eight seconds as standard. There is now available material for making up a table of exposures for any magnification at 0·50 N.A. But apertures vary just as do magnifications, and as it is well known that exposures vary in inverse ratio to the square of the aperture, it is quite easy to prepare a second table of multiplying or dividing factors for all possible apertures, by which one can multiply or divide the exposure obtained by consulting the first table for a certain magnification at 0·50 N.A. To make use of this second table it is necessary to have some means of knowing what aperture is being used, and the method must permit of the N.A. being measured immediately before making the exposure. The method employed and described by the lecturer is that due to Sir A. E. Wright, who gives it in detail in his *Principles of the Microscope*, and consists in the measurement of the Ramsden disc of the ocular. To apply the method it is required to know the equivalent focal length (say in millimetres) of the objective and the semi-diameter of the beam of light as it emerges from the back combination of the objective. The first factor is usually known, and the second factor can be obtained as follows from measurement of the Ramsden disc. A diagram of the passage of light through the microscope from the condenser to the eye was then shown. The rays, after emerging from the eyepiece, converge to a point a little in front of the eye-lens, and there form a circle of light—the "Ramsden disc" of the ocular. The

diameter of the circle of light varies with the aperture of the objective. The greater the magnifying power of the ocular, the smaller the disc. If, therefore, we hold a finely graduated measure—divided, say, into millimetres and tenths—exactly in the plane of the Ramsden disc, and focus both it and the disc simultaneously with a pocket-lens, we can read off the diameter of the disc in, say, tenths of a millimetre. Multiplying half this diameter by the magnifying power of the ocular—which is usually marked on the mount—and dividing by the focal length of the objective, gives us the required N.A. of the objective in use. Dr. Reid then gave an example. Assume that a 4-mm. objective, with an ocular magnifying four diameters, is being employed, and that the diameter of the Ramsden disc of the ocular, obtained by measurement, is 1 mm. This multiplied by the power of the ocular (4) gives us 4 mm. as the diameter of the objective beam; half of this (2 mm.) is the semi-diameter of the beam, which, divided by 4 (the focal length of the objective), gives 0·50 as the N.A. in use at the time.

Tables for exposure, calculated for various magnifications from $\times 100$ to $\times 4{,}000$, and with N.A. 0·10 to 1·30, were then projected on the screen. The lecturer had found that a single-filament Nernst lamp working at 100 v. was sixteen times more powerful than a $\frac{3}{4}$-in.-wick oil-lamp. With variously coloured, or stained, or thick objects, the exposures indicated would, of course, have to be suitably modified. If detail is required in a coloured object, it is necessary to use a screen of about the same colour as the object. All screens, whether green, yellow, or other colour, must be standardised by test exposures with and without the screen, and with the illuminant to be used, in order to know by what factor the originally obtained exposure should be multiplied. It was found that with the oil-lamp a rather dark yellow screen (Wratten & Wainwright's K3) required three and a half times the normal, and a rather dark green screen (Wratten & Wainwright's B) required six times the normal. In concluding, Dr. Reid said that those who wished to study the tables he had projected on to the screen would find them reproduced at length in *The Photographic Journal* ("Transactions" of the Royal Photographic Society) for January, 1909.

Mr. W. B. Stokes (Hon. Secretary) deprecated the use without verification of the power marked on eyepieces, and suggested that

tube-length would require consideration, as there are plenty of good objectives not provided with collar correction. He would suggest a simplification of the lecturer's method—namely, camera extension squared, divided by diameter of Ramsden circle squared, multiplied by a constant found by experiment. He assumed that objectives were all of the same transparency, and that lamp-distance and condensers, etc., remained the same.

Mr. B. J. Capell inquired as to the possible necessity of a factor taking into consideration the mounting medium—discriminating between, say, realgar and monobromide; and with respect to the use of isochromatic plates, he thought them very useful, but suggested that at times the selective power of the ordinary plate would be equal to the use of a blue screen.

In replying, Dr. Reid thought the subject would cause more variation than the medium. A knowledge of isochromatic photography was very useful, and, in fact, necessary, in photomicrography. He found that with an oil-lamp better contrast was obtained with isochromatic than with ordinary plates. It was sometimes necessary to use red-sensitive plates, and sometimes ordinary plates. It depended on the subject. Referring to Mr. Stokes's remarks *re* N.A., he would have to measure distance between eyepiece and ground-glass every time, but by the lecturer's method would only have to refer to tables.

At the meeting of the Club held on March 5th, 1909, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., Vice-President, in the Chair, the minutes of the meeting held on February 5th were read and confirmed.

Messrs. H. G. Troughton, R. Beer, and O. Collier were balloted for and duly elected members of the Club.

Mr. Lees Curties, jun., for Messrs. C. Baker, exhibited and described three new models of microscope stands just brought out by his firm. This new form of their well-known D. P. H. model is provided with a body-tube $1\frac{1}{2}$ in. in diameter, with draw-tube carrying an eyepiece 23·2 mm. in diameter. It is fitted with diagonal rack, coarse adjustment, and is carried on a limb cast in one piece, with opening to receive the fingers when lifting. The fine-adjustment milled heads work at the sides of the limb, and actuate

a lever enclosed in the centre of the limb. In Model 1 a mechanical stage giving movements of 1 in. vertical and $2\frac{1}{4}$ in. horizontal is fitted to the microscope. Model 2 is made to take detachable mechanical stage if required. The instruments have the firm's usual model tripod-claw foot, and the three models shown have respectively rack-centring substage, screw-focusing substage, and plain understage-tube.

Mr. F. J. Perks read a paper communicated by Mr. W. Wesché, F.R.M.S., on "The Structure of the Eye Surface, and the Sexual Differences of the Eyes, in Diptera."

A number of drawings illustrating some of the points raised were exhibited by Mr. Wesché.

Mr. T. B. Rosseter, F.R.M.S., read a note on "Some Work on the genus Hymenolepis, and the Description of a New Species." After shortly referring to a paper on the family Taenidae he had read before the Club in October last, the speaker reminded members that, given the hooks on the scolex, one could, with the help of Krabbe, define the specific character of a specimen; but, minus these organs of attachment, Raillett's generic formulae were to the student of but little value. Further, that Wienland's formulae for his genus Hymenolepis based upon the anatomy of the genitalia, were more reliable generically, and, in conjunction with the hooks, were of inestimable value in determining the species. Species of *Hymenolepis* (*Taenia*) *anatina* —were exhibited and shortly described. This worm attains a length of from 200 to 300 mm. and a breadth of 2 to 3 mm. A young worm of 70 mm. has about 600 segments, while the largest has probably 2,000 segments or proglottides in the strobila. Copulation takes place when the worm has attained a length of about 65 mm. The head has a simple crown of ten hooks, 65 μ to 72 μ in length.

At the meeting of the Club held on April 2nd, Mr. C. F. Rousselet, Vice-President, in the Chair, the minutes of the meeting held on March 5th were read and confirmed.

Messrs. F. W. Gordon, T. R. Saxton, and W. E. W. Baker were balloted for and duly elected members of the Club.

The Hon. Secretary gave notice that in the course of concluding a new lease with their landlords, the Royal Society of Medicine, it had been found necessary to alter the days of meeting from the first and third Fridays to the second and fourth Tuesdays. The next ordinary meeting, to be held Friday, May 7th, would be made special for the purpose of altering Rules 1 and 9 to accord with the new arrangement. The new lease would take effect from June next.

Mr. C. Lees Curties, F.R.M.S., of Messrs. Baker, gave an exhibition of some of the different illuminants for the microscope. He said that the subject was a very large one, and it would be quite easy to cover all the available table-space with the different forms of apparatus designed from time to time to this end. He proposed, however, to confine himself to lamps, but, owing to the limited number of plugs available, could only exhibit three electric lamps at a time. He was showing some paraffin and electric lamps in comparison.

First as to the evenness of illumination of the field.

Second: Intensity.

Third: Colour and the advantage of screens.

All the six microscopes shown had $\frac{1}{12}$-in. oil-immersion objectives of N.A. 1·30, eyepieces No. 4, and Abbe condensers (not achromatic). The specimen shown was *Pleurosigma angulatum*.

The first microscope was illuminated by a $\frac{1}{2}$-in.-wick paraffin lamp, edge of flame, and the diatom was perfectly resolved; but the sides of the field were not evenly illuminated.

The second stand had the same kind of lamp, but with the addition of the small illuminating lens lately suggested by Mr. E. M. Nelson. The resolution was as perfect as in No. 1, and the field was evenly lighted.

The third microscope also had a $\frac{1}{2}$-in.-wick lamp as illuminant, but a green glass screen was employed. The extra sharpness and improved definition well illustrated the advantage of the use of suitable screens for such work. Microscope No 4 had similar optical parts and specimen, and was to have been illuminated by a Nernst electric, but which, owing to failure of the resistance, was not available. When such an illuminant is employed, owing to the narrow filament, only a small part of the field is lighted. By employing the ground-glass screen supplied with the lamp, even illumination may be obtained, but

somewhat at the loss of resolution and of course of intensity of light.

The fifth exhibit was lighted by a Nernst electric and Nelson formula double condenser, and showed living bacteria with dark-ground illumination.

The sixth stand had the same optical parts as the others, except that the condenser had an oil-immersion, and the specimen was *Amphipleura pellucida* in realgar. The illuminant was Barnard's form of mercury-vapour lamp. A micro-spectroscope was also provided to demonstrate the effect of the realgar in nearly cutting out the violet and blue lines of the mercury spectrum.

A very hearty vote of thanks was returned to Mr. Lees Curties for his interesting exhibit.

A paper by Messrs. E. Heron-Allen, F.L.S., F.R.M.S., and Arthur Earland on "A New Species of Technitella from the North Sea, with Some Observations upon Selective Power as exercised by Certain Species of Arenaceous Foraminifera," was read by Mr. Earland. The paper made no attempt to explain either the processes by which the tests of Arenaceous Foraminifera are constructed, or the idiosyncrasies displayed by many of the genera and species in the choice of materials. But the discovery of a species in the construction of whose test the utmost limit hitherto observed is reached, both as regards construction and selection, seemed to the authors a fitting opportunity to assemble and record some of the facts that present themselves to the student whilst observing these more or less highly specialised organisms.

Mr. E. F. Law gave a lecture, illustrated with photomicrographs in the lantern, on "The Relation between the Microscopic Structure and Properties of Alloys." He said that the only additional piece of apparatus required for the study of opaque objects was an illuminator such as the Sorby-Beck for low powers, and for higher powers a right-angled prism behind the objective or a transparent mirror, such as a cover-glass. In such cases the light was reflected through the objective on to the specimen and back again to the eyepiece. Dealing with the preparation of metal sections for microscopical examination, the usual method was to obtain a section from a selected sample by sawing or breaking up the mass. The piece was then filed to get a level

surface, then polished on a series of emery papers of increasing fineness—usually attached to a disc rotated by an electric motor. The final polish was given by a cloth-wheel charged with ordinary jewellers' rouge. This method will give a sufficiently high polish as to eliminate all scratches under all but the highest powers. After polishing a section, it should always be examined before etching for blow-holes, etc., due to foreign matter entangled in the metal. A photomicrograph taken at × 100 was shown on the screen of a polished surface of steel, in which was a thread of slag showing as a black line on the white ground of the polished metal. Another photograph showed the presence of two kinds of slag, one darker than the other. The line of slag indicates the direction in which the steel has been rolled. If a surface is polished with soft material, the harder constituent will stand out in relief above the softer one. A number of very interesting slides taken by the Autochrome process were shown, well exhibiting the colours of the constituents brought out by heat-tinting.

On April 3rd, the Quekett Microscopical Club commenced their Saturday afternoon excursions for the season, visiting, by kind permission of the secretary of the Royal Botanic Society, the Botanical Gardens, Regent's Park. The attendance, though not a record, was good, thirty-five members taking advantage of the fine afternoon. Notwithstanding the late spring and recent cold weather, the water of the lake yielded abundance of microscopic life. Free-swimming Rotifera were particularly plentiful, both in species and numbers. Pterodina and many species of Brachionus were made out. Several members, before leaving, announced the capture of Melicerta, and one believed he had acquired Fredericella. Infusoria were plentiful, among them Stentor. Several Hydras were recorded, and the usual Entomostraca (Chydorus, etc.), with some of the Nauplius forms. Among Algae, two species of Closterium were recognised, and, on plant-pots in one of the conservatories, Symploca, and a fine example of Chroococcaceae.

At the meeting of the Club held on May 7th, 1909, Prof. E. A. Minchin, M.A., President, in the Chair, the minutes of the meeting held on April 2nd were read and discussed.

Messrs. M. D. Ewell and W. F. Hertzberg were balloted for and duly elected members of the Club.

After the usual announcements and notices, the meeting became special for the purpose of considering and passing alterations to the rules of the Club, numbers 1 and 9, necessitated by the conditions of the new lease just concluded. The effect of the alteration is to make the ordinary meeting take place on the fourth Tuesday in the month, and the "Gossip" meeting on the second Tuesday, instead of first and third Fridays respectively. The alteration, so far as the ordinary meetings are concerned, takes effect on and from October 26th, 1909.

Having left the Chair (which was temporarily occupied by Dr. E. J. Spitta, F.R.A.S., F.R.M.S., Vice-President), the President delivered the annual presidential address, postponed from February 5th, taking as his subject "Some Applications of Microscopy to Modern Science and Practical Knowledge."

The Chairman proposed a very hearty vote of thanks to the President for his most interesting address. Acknowledging this, the President said he was very much indebted to Messrs. Angus & Co. for the loan of the microscopes employed in exhibiting the preparations he had brought up, and particularly so on that evening, as microscopes were in great demand at the meeting of another society elsewhere.

At the meeting of the Club held on June 4th, 1909, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., Vice-President, in the Chair, the minutes of the meeting held on May 7th were read and confirmed

Messrs. P. Oakenfull, F. G. Baxendale, S. W. Pring, A. L. Dixon, J. E. Hunter, J. S. Dunkerley, and W. H. L. Baddeley were balloted for and duly elected members of the Club.

The Hon. Secretary drew the attention of members to the advantages offered by the Marine Biological Association of the West of Scotland. The station is at Millport, Great Cumbrae,

and is easily reached from Glasgow. The charge for the use of tables in the laboratory is from 10*s*. 6*d*. per week.

Mr. C. Lees Curties, F.R.M.S., exhibited, for Mr. Walter Bagshaw, a specimen of *Navicula lyra* showing abnormal markings. Several such specimens had been found in the same gathering.

Dr. Spitta said that the variability of diatoms was so marked that he understood it was one of the chief reasons that had led Prof. Abbe to introduce his "test-plate." Referring to *Navicula Smithii*, Dr. van Heurck had informed him that this also was a very variable species, and as a test-object was not reliable unless it was ascertained that the specimens discussed were from the same locality and were alike.

Mr. T. A. O'Donohoe exhibited a high-power photomicrograph, and also the original preparation under a microscope, of blood corpuscles of newt, showing chromosomes (?).

Mr. F. Martin Duncan, F.R.P.S., gave a lantern lecture on the "Romance of Forest Life," dealing in a very interesting manner with his own observations of the fauna, as to their habits and peculiarities, especially of the New Forest area. He said that the depredations of professional collectors were much to be deplored, and it was much to be desired that this New Forest area should be made into a reservation where the fast-dwindling species of animals and plants of these islands might be protected and afforded a last standing-ground. The forest is in every way suitable. It covers a wide area, and has almost all conditions of soil, etc. He thought that every animal and plant known in the British Isles could adapt itself there.

Owing to holiday week and the threatening weather, the excursion of the Club on Saturday, June 5th, to Epping Forest was not quite so well attended as usual. However—due, no doubt, in large measure to the skilful pilotage of Mr. Wilson, of Walthamstow, who is well acquainted with the forest—those members who formed the party were amply repaid for their trouble. The list of "pond-life" captures is altogether too extensive to record in detail; but among them may be mentioned: *Stentor nigra* and *viridis*, *Plumatella repens* (in quantity),

Melicerta, Volvox, water-mites (several species), Hydra, Epistylis, Vorticellidae, and *Conochilus volvox*. The weather belied its promise of wet, and was most favourable; and after tea at one of the inns in the forest, Blackbush Plain and the Cuckoo Ponds were visited, ending a most successful excursion.

Campbell

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Printed by Hazell, Watson & Viney, Ld., London and Aylesbury.

OFFICERS AND COMMITTEE.

(Elected February 1909.)

PRESIDENT:

EDWARD ALFRED MINCHIN, M.A., F.Z.S.

VICE-PRESIDENTS:

RT. HON. SIR FORD NORTH, F.R.S.
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HENRY MORLAND.
E. J. SPITTA, F.R.A.S., F.R.M.S.

COMMITTEE:

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HON. TREASURER:

F. J. PERKS, 48, Grove Park, Denmark Hill, S.E.

HON. SECRETARY:

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HON. ASSISTANT SECRETARY:

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HON. SEC. FOR FOREIGN CORRESPONDENCE:

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HON. REPORTER:

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HON. EDITOR:

FRANK P. SMITH, 5, Gibson Square, N.

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PAST PRESIDENTS.

	Elected
*EDWIN LANKESTER, M.D., F.R.S.	July 1865.
*ERNEST HART	,, 1866.
*ARTHUR E. DURHAM, F.R.C.S., F.L.S., etc.	,, 1867-8.
*PETER LE NEVE FOSTER, M.A.	,, 1869.
*LIONEL S. BEALE, M.B., F.R.S., etc.	,, 1870-1.
ROBERT BRAITHWAITE, M.D., F.L.S., etc.	,, 1872-3.
*JOHN MATTHEWS, M.D., F.R.M.S.	,, 1874-5.
*HENRY LEE, F.L.S., F.G.S., F.R.M.S., F.Z.S.	,, 1876-7
*THOS. H. HUXLEY, LL.D., F.R.S., etc.	,, 1878.
*T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., etc.	,, 1879.
T. CHARTERS WHITE, M.R.C.S., L.D.S., F.R.M.S.	,, 1880-1.
M. C. COOKE, M.A., LL.D., A.L.S.	,, 1882-3.
*W. B. CARPENTER, C.B., F.R.S., etc., etc.	,, 1884.
A. D. MICHAEL, F.L.S., F.R.M.S., etc.	,, 1885-6-7
B. T. LOWNE, F.R.C.S., F.L.S., etc.	Feb. 1888-9.
*Rev. W. H. DALLINGER, LL.D., F.R.S., F.R.M.S., etc., etc.	,, 1890-1-2.
EDWARD MILLES NELSON, F.R.M.S.	,, 1893-4-5.
*J. G. WALLER, F.S.A.	,, 1896-7.
JOHN TATHAM, M.A., M.D., F.R.M.S.	,, 1898-9.
GEORGE MASSEE, F.L.S.	Feb. 1900-1-2-3.
EDMUND J. SPITTA, L.R.C.P., M.R.C.S., F.R.A.S., F.R.M.S.	Feb. 1904-5-6-7.

* Deceased.

HONORARY MEMBERS.

Date of Election.

Jan. 24, 1868. Arthur Mead Edwards, M.D., 423, Fourth Avenue, Newark, New Jersey, U.S.A.

Feb. 17, 1893. Robert Braithwaite, M.D., F.L.S., F.R.M.S. (*Past President*), 26, Endymion Road, Brixton Hill, S.W.

Feb. 17, 1893. M. C. Cooke, M.A., LL.D., A.L.S. (*Past President*), 53, Castle Road, Kentish Town, N.W.

Feb. 17, 1893. T. Charters White, M.R.C.S., L.D.S., F.R.M.S. (*Past President*), 6, Wellington Villas, Stopford Road, Jersey.

Mar. 19, 1897. B. T. Lowne, M.D., F.R.C.S., F.L.S., etc. (*Past President*), The Cedars, Crondall, near Farnham, Surrey.

May 18, 1906. Dr. Eugène Penard, Rue Töpffer 3, Geneva.

LIST OF MEMBERS.

Date of Election.	
Feb. 16, 1906.	Abson, Herbert, 14, Gainsborough Road, Mile End, E.
Feb. 16, 1906.	Akehurst, Sydney Charles, 60, Bowes Road, Palmer's Green, N.
May 17, 1907.	Akerman, Captain C. S., R.E. Royal Military Academy, Woolwich, S.E.
Feb. 19, 1904.	Allardice, Lieut. Wm. McDiarmid, c/o Messrs. Sir C. M. McGregor, Bt., & Co., 25, Charles Street, St. James's Square, London, S.W.
Nov. 16, 1900.	Allcock, J. F., "Brambletighe," Cambridge Road, Wanstead, Essex.
April 18, 1890.	Allen, J. M., F.R.M.S., 11, Gray's Inn Square, W.C.
June 16, 1905.	Allwood, Selwyn H., Jackson Town P.O., Jamaica, W. Indies.
Dec. 15, 1899.	Angus, H. F., Enderley, Bushwood, Leytonstone.
June 21, 1907.	Arpin, John Edward, 131, Castlenau, Barnes, S.W.
Feb. 17, 1905.	Asals, John, Paso de Robles, The Drive, Loughton.
Feb. 22, 1889.	Ashe, A., F.R.M.S., Roman Villa, Laurie Square, Romford, Essex.
Dec. 15, 1899.	Ayrton, William, "The Cliff," Beccles, Suffolk.
June 4, 1909.	Baddeley, Wm. H. L., 29, Church Crescent, Church End, Finchley, N.
April 17, 1903.	Bagshaw, Walter, J.P., F.R.M.S., "Moorfield," Birkenshaw, near Bradford, Yorks.
Sept. 26, 1884.	Baker, F. W. W., F.R.M.S., 313, High Holborn, W.C.
Mar. 16, 1906.	Baker, Henry James, 13, Moorgate Street, E.C.

Date of Election.	
Mar. 20, 1908.	Banfield, Arthur Clive, 13F, Cornwall Mansions, N.W.
June 19, 1908.	Banham, Edward Elliott, 128, Uxbridge Road, West Ealing, W.
Mar. 21, 1902.	Barker, John W., B.Sc., A.R.C.S., 8, Balcaskie Road, Eltham Park, Kent.
June 19, 1908.	Barnard, Joseph Edwin, F.R.M.S., Park View, Brondesbury Park, N.W.
Mar. 19, 1886.	Barnes, W., 24, Shaftesbury Road, Hornsey Rise, N.
May 25, 1883.	Barratt, Thomas J., F.R.M.S., Bell Moor House, Upper Heath, Hampstead, N.W.
Feb. 16, 1900.	Barrett, R. H., The Homestead, Berkhampsted.
Sept. 27, 1872.	Bartlett, Edward, L.D.S., M.R.C.S.E., 38, Connaught Square, W.
June 16, 1905.	Barton, William Charles, Willeslie House, 43, Rosary Gardens, South Kensington, S.W.
June 17, 1892.	Bates, C., 1, Windsor Road, Denmark Hill, S.E.
Oct. 18, 1895.	Baugh, J. H. A., 63, Cambridge Road, Hammersmith, W.
June 4, 1909.	Baxendale, Frederick G., 27, Hawes Road, Bromley, Kent.
Jan. 16, 1891.	Baxter, W. E., F.R.M.S., 170, Church Street, Stoke Newington, N.
June 19, 1908.	Bayliffe, John H., The Moorings, Essex Road, Burnham-on-Crouch.
Nov. 26, 1875.	Beaulah, John, Raventhorpe, Brigg.
July 25, 1884.	Beck, C., F.R.M.S., 68, Cornhill, E.C.
Dec. 20, 1907.	Beckett, Frederic Franklin, 114, Manor Park, Lee, S.E.
Mar. 5, 1909.	Beer, Rudolf, B.Sc., F.L.S., "Westwood," Bickley, Kent.
Feb. 5, 1909.	Beresford, Joseph Andrew, 7, Clephane Road, Canonbury, N.
Feb. 16, 1906.	Bestow, Charles H., 43, Upper Clapton Road, N.E.
Jan. 20, 1899.	Bird, Richard, 15, Woodstock Street, W.
Mar. 20, 1908.	Blackbourn, Basil, Hoo, Minster, near Ramsgate.
June 16, 1905.	Blair, William Nisbet, 23, West Hill, Highgate, N.

Date of Election.

Oct. 2, 1908. Blockley, Edgar A., 26, Mayfield Avenue, Chiswick, W.

May 19, 1899. Blood, Maurice, M.A., F.C.S., F.R.M.S., 16, Alexandra Road, Kingston Hill, Surrey.

Nov. 17, 1905. Bonser, Thomas Edward, 160, East Dulwich Grove, S.E.

Nov. 15, 1907. Bradford. William Barnes, 65, Tyrwhitt Road, St. John's, S.E.

Nov. 17, 1905. Bremner, John Unthank, 277, King Street, Hammersmith, W.

Nov. 6, 1908. Broad, John Moxon, 2, Nicoll Road, Harlesden, N.W.

Mar. 21, 1902. Brook-Fox, F. G., Townsend House, Halberton, Tiverton.

Feb. 17, 1905. Brooks, Howard, Cedarhurst, St. Albans.

Dec. 4, 1908. Brooks, Theodore, F.R.M.S., British Vice-Consul, Guantanamo, Cuba.

Dec. 19, 1890. Brough, J. R., 29, Alexandra Villas, Finsbury Park, N.

Mar. 15, 1907. Browett, William "Beaumont" Pearfield Road, Forest Hill, S.E.

Nov. 17, 1905. Brown, Charles H., Post Office, Launceston, Tasmania.

Jan. 18, 1907. Brown, Nicholas Edward, 6, The Avenue, Kew.

Jan. 28, 1887. Browne, E. T., B.A., F.R.M.S., 141, Uxbridge Road, W.

Mar. 18, 1904. Brushfield, N. W., 13, Allfarthing Lane, Wandsworth Common, S.W.

Jan. 15, 1892. Bryce, D., 37, Brooke Road, Stoke Newington Common, N.

May 15, 1908. Bunting, Percival J., Lindley, O.R.C., South Africa.

Jan. 20, 1905. Burnell, Charles Edward, 29, High Street, Shepton Mallet.

April 20, 1906. Burrell, T. Leonard, 22, Fairbridge Road, Upper Holloway, N.

Feb. 19, 1904. Burton, James, 11, Ulysses Road, West Hampstead, N.W.

Date of Election.

Jan. 15, 1904.	Butcher, Lewis, 82, Barn Mead Road, Beckenham, Kent.
Feb. 19, 1904.	Butterworth, Arthur Cyrus, F.R.M.S., Glanville, Crowstone Road, Westcliff-on-Sea.
June 14, 1865.	Bywater, W. M., F.R.M.S., "Invicta," 33, Telford Avenue, Streatham Hill, S.W.
April 15, 1904.	Caffyn, Charles Henry, 32, Falkland Road, Hornsey, N.
June 18, 1897.	Campbell, Colney, 47, Selborne Road, Southgate, N.
Mar. 16, 1906.	Capell, Bruce John, 10, Castelnau, Barnes, S.W.
Jan. 20, 1905.	Carrington, John, P.O. Box 48, East London, South Africa.
June 17, 1892.	Chaloner, G., F.C.S., Combe House, Colyton, Axminster.
Mar. 17, 1905.	Chapman, David Leighton, 100, Tooley Street, S.E.
June 4, 1904.	Cheavin, Harold Squier, 70, Somerset Road, Huddersfield.
Mar. 22, 1878.	Chester, The Very Rev. the Dean of, The Deanery, Chester.
Dec. 18, 1891.	Cheyne, A. M., 16, Coleman Street, E.C.
Dec. 18, 1896.	Chipps, F. W., 201, Castelnau, Barnes, S.W.
Jan. 20, 1905.	Christie, John, F.R.M.S., Henleighs, Kingston Hill, Surrey.
May 18, 1906.	Churchouse, G., 30, Natal Road, Bowes Park, N.
Jan. 19, 1906.	Clarke, William Roger, 18, Gayton Road, Hampstead, N.W.
May 15, 1903.	Cleave, A. H. W., F.R.M.S., Royal Mint, Ottawa, Canada.
Mar. 17, 1905.	Clemence, Walter, Farringford, Walton-on-Thames.
Oct. 18, 1907.	Coldwells, William Henry, Redcote, Shirley Road, Wallington, S.O.
Mar. 5, 1909.	Collier, Oswald, The Hermitage, Snaresbrook.
Nov. 16, 1906.	Collins, Brenton Robie, M.A., Gorsebank, Matfield, Paddock Wood, Kent.
Oct. 21, 1904.	Conrady, Alexander Eugen, F.R.A.S., F.R.M.S., 23, Flanchford Road, Stamford Brook, W.

Date of Election.

Nov. 18, 1904.	Cooper, Arnold W., J.P., F.R.M.S., Richmond, Natal.
May 28, 1869.	Cottam, Arthur, F.R.A.S., Furze Bank, Durleigh Road, Bridgwater.
April 20, 1906.	Couch, Robert Percy, "Montrose," 44, Radcliffe Road, Winchmore Hill, N.
Jan. 18, 1901.	Cox, Thomas N., jun., 104, Tressillian Road, Brockley, S.E.
Jan. 15, 1904.	Cox, William, 113, Manor Road, Brockley, S.E.
June 19, 1903.	Coxhead, G. W., Leamington House, Rookwood Road, Stamford Hill, N.
Dec. 20, 1901.	Craig, Thomas, F.R.M.S., 26, Selkirk Avenue, Montreal, Canada.
Nov. 21, 1902.	Cressey, Dr. G. H., Oak Manor, Tonbridge.
Aug. 28, 1868.	Crisp, Sir Frank, LL.B., B.A., F.R.M.S., *V.P. and Treas. Linnean Society*, 5, Lansdowne Road, Notting Hill, W.
Mar. 20, 1908.	Croger, Frank Clifford, 114, Wood Street, E.C.
Nov. 16, 1906.	Crosbie, Walter, The Chestnuts, Lyonsdown, New Barnet.
Feb. 16, 1900.	Crossland, R. E., A.R.I.B.A., 10, Sergeants Inn, Fleet Street, E.C.
Dec. 21, 1906.	Cullin, William George, 182, Tottenham Court Road, W.
Mar. 16, 1894.	Culshaw, Rev. George H., M.A., The Rectory, Iver Heath, Bucks.
April 18, 1902.	Cumming, John, 29, Ella Road, Crouch End, N.
June 25, 1880.	Curties, C. Lees, F.R.M.S., 244, High Holborn, W.C.
Jan. 16, 1903.	Curties, C. L., jun., 244, High Holborn, W.C.
May 18, 1906.	Cuzner, Edgar, 36, Trothy Road, Bermondsey, S.E.
Nov. 18, 1904.	Dade, Willoughby Dreyer, 6, Montague Road, Richmond, Surrey.
Jan. 17, 1908.	Dallas, Charles Caldwell, F.R.G.S., F.Z.S., Eastley Wootton, New Milton, Hants.
Jan. 16, 1903.	Damant, Lieut. Guybon, R.N., Lammas, East Cowes.
Dec. 21, 1906.	Darlaston, Herbert William Hutton, 31, Freer Road, Birchfield, Birmingham.

Date of Election.	
Jan. 19, 1906.	Dauncey, Rev. Albert Augustus, 26, Ulundi Road, Westcombe Park, Blackheath, S.E.
Mar. 15, 1895.	Daunou, F., 1, Shirley Villas, Westbrook, Margate.
June 16, 1905.	Davies, Daniel, F.R.M S., 98, Algernon Road, Ladywell, Lewisham, S.E.
May 18, 1906.	Davies, E. Averst, 124, Croydon Road, Anerley, S.E.
Jan. 19, 1906.	Davies, Perceval Eckton, Abbeydale, Marmora Road, Honor Oak, S.E.
Nov. 23, 1888.	Davis, H. R., Thistleton House, 1, Clissold Road, Stoke Newington.
Jan. 18, 1901.	Davis, Thomas John, F.R.M.S., 62, Sale Street, Rose Hill, Derby.
Mar. 17, 1905.	Dean, Frank, 10, Lansdowne Road, Holland Park, W.
May 17, 1901.	Deeley, George P., Moushall, Amblecote, Brierley Hill, Staffordshire.
April 19, 1895.	Delcomyn, Theo. A., F.R.M.S., "Feldheim," Wimbledon Common.
Nov. 17, 1893.	Dennis, A. W., 56, Romney Buildings, Milbank, S.W.
Mar. 22, 1889.	Dick, J., Milber, Victoria Road, Mill Hill, N.W.
Feb. 15, 1907.	Dilks, Arthur Charles, Tardebigge, Bromsgrove.
June 4, 1909.	Dixon, Arthur L., 35, North Hill, Highgate, N.
June 17, 1892.	Dixon-Nuttall, F. R., F.R.M.S., "Ingleholme," Eccleston Park, near Prescot, Lancashire.
Jan. 1, 1909.	Dodd, Frederick H., F.R M.S., 51, Shooters Hill, Road, Blackheath, S.E.
Mar. 17, 1899.	Downs, Arthur, 2, Woodside Villas, Ulverston Road, Walthamstow.
May 17, 1907.	Drinkwater, Jesse, F.R.M.S., St. Margaret's, Stanley Gardens, Wallington.
Nov. 15, 1901.	Druett, C. R., 30, Uxbridge Road, W.
June 4, 1909.	Dunkerley, John S., 302, Trinity Road, Wandsworth, S.W.
June 19, 1891.	Earland, Arthur, Reading Villa, Denmark Street, Watford.

Date of Election.

May 15, 1908. East, John Holtham, 46, Cherington Road, Hanwell, W.

Sept. 25, 1868. Eddy, J. R., F.R.M.S., F.G.S., The Grange, Carleton, Skipton, Yorkshire.

Feb. 21, 1902. Edwards, Thomas Jarvis, 9, St. Lawrence Road, Brixton, S.W.

May 26, 1876. Emery, Charles, 10, Barrington Road, Crouch End, N.

April 17, 1896. Enock, F., F.L.S., F.R.M.S., F.E.S., 13, Tufnell Park Road, Holloway, N.

Feb. 28, 1879. Epps, Hahnemann, 95, Upper Tulse Hill, Brixton, S.W.

Dec. 20, 1907. Evans, Benjamin, 162, Battersea Bridge Road, S.W.

Nov. 17, 1905. Evans, Morris B., 33, Lady Margaret Road, Southall, Middlesex.

May 5, 1909. Ewell, Dr. Marshall D., F.R.M.S., 59, Clark Street, Chicago, Ill., U.S.A.

Feb. 15, 1901. Eyre, Frederick W., Inland Revenue, Somerset House, W.C.

Feb. 17, 1899. Fairholme, H. W., Blenheim Mansions, Queen Anne's Gate, S.W.

July 25, 1873. Fase, Rev. H. J., M.A., 65, Brodrick Road, Upper Tooting, S.W.

Dec. 21, 1906. Fawcett, Henry Hargreave, 24, Cambridge Road, Cottenham Park, Wimbledon, S.W.

June 16, 1893. Filer, Frank E., 35, Dancroft Road, Herne Hill, S.E.

Feb. 19, 1904. Finlayson, David, "Redfern," Pellatt Grove, Wood Green, N.

June 19, 1908. Flamank, Sydney W., Dunbar House, Marchmont Road, Richmond, Surrey.

Mar. 20, 1896. Fletcher, S. W., M.D., Pepperill, Massachusetts, U.S.A

Nov. 23, 1888. Flood, W. C., 119, Highbury Hill, N.

April, 19, 1907. Ford, Tom Alonzo, 9, Parolles Road, Highgate, N.

June 23, 1871. Freeman, H. E., Walcot, Limes Avenue, New Southgate, N.

Date of Election.

Jan. 18, 1901. Freeman, Rev. Richard, M.A., Whitwell Vicarage, Reepham, Norfolk.

Dec. 16, 1898. French, Archibald J., 10, Radford Road, Lewisham, S.E.

Jan. 18, 1907. Fuelling, George Ernest, 195, High Road, Streatham, S.W.

May 20, 1898. Fuller, Frederick, M.A., LL.D., 9, Palace Road, Surbiton.

May 15, 1903. Gabb, G. H., F.C.S., 83, Crayford Road, Tufnell Park, N.

Dec. 15, 1905. Gardner, Edward Lewis, 18, Craven Road, Harlesden, N.W.

Jan. 20, 1899. Gardner, William, F.R.M.S., 292, Holloway Road, N.

Dec. 16, 1904. Garnett, Theodore, M.A. Oxon., South Bank, Grassendale, Liverpool.

Nov. 18, 1904. Gibbs, Henry James, 63, Leigham Court Road, Streatham, S.W.

May 17, 1901. Gladding, Harold, 39, Dowkin Street, Port Elizabeth, Cape Colony.

April 26, 1872. Goodinge, J. W., F.R.G.S., 10, Gower Street, Bedford Square, W.

April 2, 1909. Gordon, Fred Wm., F.R.M.S., "Woodfield," Lytton Grove, Putney Hill, S.W.

Jan. 16, 1903. Gordon, Rev. W. H., "Woodcroft," Fareham, Hants.

May 17, 1907. Graham, Charles E., 50, Woodstock Road, Upper Walthamstow.

Nov. 15, 1907. Gray, W., 132, Packington Street, Islington, N.

Nov. 17, 1899. Green, E. E., c/o Secretary, Royal Societies Club, St. James's Street, S.W.

Jan. 16, 1903. Green, H. O., 4, Leamington Gardens, Seven Kings.

Nov. 20, 1903. Griffiths, A. B., Ph.D., 78, Stockwell Park Road, S.W.

Nov. 18, 1898. Grocock, L. O., 167, Venner Road, Sydenham, S.E.

May 17, 1895. Groves, H., F.L.S., 21, Sibella Road, Clapham Rise, S.W.

Date of Election.

Nov. 18, 1904. Guppy, Robert John Lechmere, Kinersly, Port of Spain, Trinidad, W. Indies.
Feb. 19, 1904. Gurney, Robert, Ingham Old Hall, Stalham, Norfolk.

Sept. 28, 1888. Hall, T. F., 39, Gloucester Square, Hyde Park, W.
Feb. 20, 1903. Hall, W. D., "Monte Rosa," 87, Stradella Road, Herne Hill, S.E.
Oct. 22, 1886. Hampton, W., The Manor House, Weston, Staffordshire.
May 19, 1905. Harris, Charles Poullet, M.D., M.R.C.S., L.R.C.P., F.R.M.S., 98, Lower Addiscombe Road, Croydon.
Jan. 18, 1895. Harrison, A., F.R.M.S., "Delamere," Grove Road, South Woodford, Essex.
May 17, 1901. Harvey, Sidney, F.I.C., F.C.S., Watling House, Canterbury.
Dec. 21, 1906. Hasslacher, Charles John, 3, Kensington Park Gardens, W.
Mar. 28, 1879. Hawkins, C. E., 23, Dalebury Road, Upper Tooting, S.W.
Feb. 15, 1901. Headley, F. W., Haileybury College, Hertford.
Mar. 16, 1906. Heath, Charles Edward, 178, Loughboro' Road, Brixton, S.W.
Jan. 19, 1906. Heath, Charles Emanuel, F.R.M.S., 178, Loughboro' Road, Brixton, S.W.
Feb. 5, 1909. Hebdon, William, 181, Breakspears Road, Brockley, S.E
Aug. 23, 1872. Hembry, F. W., Langford, Sidcup, Kent.
April 20, 1906. Herbert, Robert Henry, 32, Fairmead Road, Holloway, N.
Feb. 21, 1908. Heron-Allen, Edward, F.L.S., F.R.M.S., F.R.Met.S., F.Z.S., 3, Northwich Terrace, Maida Hill, N.W.
Feb. 26, 1886. Hewlett, R. T., 46, Gussenhall Road, Southfields, S.W.
Dec. 20, 1901. Hicks, Frederick H., Belmont Villas, Wallington, Surrey.

Date of Election.	
Feb. 17, 1899.	Hill, Edward J., Darnlee, Melrose, N.B.
Nov. 17, 1893.	Hill, Edwin Ernest, F.R.M.S., 3, Trevor Villas, Horn Lane, Woodford Green, Essex.
Nov. 15, 1895.	Hilton, A. E., 21, Ashmount Road, Upper Holloway, N.
May 15, 1908.	Hiscott, Thomas Henry, F.R.M.S., 22, Upper Addison Gardens, Holland Park, W.
Jan. 19, 1906.	Hobbs, Frank William, "Ruthven," Dorlcote Road, Wandsworth Common, S.W.
Nov. 16, 1906.	Hocking, William John, Royal Mint, E.
Dec. 15, 1893.	Holder, J. T., 114, Pepys Road, New Cross, S.E.
Feb. 26, 1875.	Holford, Christopher, 5, Northumberland Avenue, Upper Richmond Road, Putney, S.W.
Dec. 20, 1907.	Holmes, Frederick, "Salerno," Stanley Road, Woodford, Essex.
Jan. 15, 1904.	Hopkinson, John, F.L.S., F.G.S., F.R.M.S., Weetwood, Watford.
Oct. 26, 1866.	Horncastle, Henry, "Lindisaye," Woodham Road, Woking.
April 21, 1893.	Hornsby, E. W., jun., 25, Old Change, E.C.
April 15, 1898.	Hounsome, John, 21, Edith Road, Plashet Grove, East Ham, E.
May 22, 1874.	Hovenden, C. W., F.R.M.S., Chester House, Mount Ephraim Road, Streatham, S.W.
April 26, 1867.	Hovenden, Frederick, F.R.M.S., "Glenlea," Thurlow Park Road, West Dulwich, S.E.
Nov. 19, 1897.	Howard, Arthur, 60, Palace Gardens Terrace, W.
Dec. 4, 1908.	Howard, George, Sitwell Vale, Moorgate, Rotherham, Yorks.
Oct. 19, 1894.	Howard, R. N., M.R.C.S., F.R.M.S., The Cape Copper Co., Ookiep, Port Nolloth, Namaqualand, Cape Colony, South Africa.
Oct. 19, 1894.	Hughes, F., Wallfield, Reigate.
May 28, 1886.	Hughes, W., 32, Heathland Road, Stoke Newington, N.
June 4, 1909.	Hunter, John E., "Strathblane," Park Road, Wallington.
Dec. 20, 1901.	Hurrell, Harry Edward, 25, Regent Street Great Yarmouth.

Date of Election.

April 18, 1902.	Imboden, Walter, F.R.M.S., 1, Hornton Street, Kensington Gardens, W.
May 24, 1867.	Ingpen, J. E., F.R.M.S., St. John's, Wrotham Road, Broadstairs.
Feb. 16, 1906.	Inwards, Richard, 6, Croftdown Road, Highgate Road, N.W.
Feb. 21, 1908.	Jackson, Joseph C., 34, Cornwall Avenue, Wood Green, N.
Apr. 20, 1906.	Jeffery, John Hugh, 10, Daysbrook Road, Streatham Hill, S.W.
Nov. 6, 1908.	John, Ambrose Hilton, 6, Brook Street, Stoke-on-Trent.
Sept. 18, 1891.	Johnson, W., 188, Tottenham Court Road, W.C.
Nov. 17, 1905.	Jones, Arthur Morley, 11, Eaton Rise, Ealing, W.
Jan. 18, 1907.	Jones, Rev. Robert Francis, 97, Fort Road, Bermondsey, S.E.
Nov. 17, 1905.	Karleese, Benjamin, The Dell, Barnt Green, Worcestershire.
May 23, 1873.	Karop, G. C., M.R.C.S., F.R.M.S., etc., Inniscorig, Beltinge Road, Herne Bay.
June 21, 1907.	Kemp, Francis H. N. C., 5, Cathcart Hill, N.
Feb. 20, 1903.	Kent, F. J., 83, Gordon Hill, Enfield, Middlesex.
Nov. 15, 1907.	Kerans, Captain Arthur Lees, "Verdahla," Cheltenham.
July 25, 1884.	Kern, J. J., "Fern Glen," Selhurst Park, South Norwood, S.E.
Nov. 18, 1904.	Kew, H. Wallis, 12, Herndon Road, Wandsworth, S.W.
May 17, 1901.	Kingsford, T. G., 1, Fortescue Villas, Stafford Road, Wallington, Surrey.
Nov. 20, 1903.	Kirkaldy, G. W., F.E.S., 1649, Nuuanu Avenue, Honolulu, Hawaii.
May 17, 1901.	Kirkman, Hon. Thomas, M.L.C., F.R.M.S., Croftlands, Esperanza, Natal.
May 19, 1905.	Kitchin, Joseph, F.R.M.S., "Ingleneuk," 14, Brackley Road, Beckenham, Kent.

Date of Election.

Mar. 22, 1889.	Klein, S. T., F.R.A.S., F.L.S., F.R.M.S., "Hatherlow," Raglan Road, Reigate.
Feb. 20, 1903.	Klingler, E. W., 25, Jackson Road, Holloway, N.
June 19, 1908.	Knaggs, Henry V., L.R.C.P. Edin., M.R.C.S. Eng., 189, Camden Road, N.W.
Feb. 17, 1905.	Lambert, Charles Alexander, Bank of New South Wales, Warwick, Queensland.
Nov. 21, 1902.	Langton, W. H., 677, Holloway Road, N.
Jan. 18, 1907.	Larkin, Thomas Gaisford, 29, Thornlaw Road, West Norwood, S.E.
Nov. 17, 1905.	Laughton, Herbert Furnell, 24, Oakley Square, N.W.
June 17, 1904.	Lawrence, Frederick George, c/o Lionel Samson & Son, Cliff Street, Fremantle, West Australia.
Mar. 16, 1900.	Lawson, Peter, "Jesmond Dene," 87, Finlay Street, Fulham, S.W.
Jan. 1, 1909.	Leadbeater, Herbert C., 40, Galveston Road, East Putney, S.W.
Oct. 21, 1904.	Lee, Major-Gen. Henry Herbert, "The Mount," Dinas Powis, near Cardiff.
Jan. 20, 1905.	Lees, Rev. Frederick Clare, 45, Cavendish Road, Sutton, Surrey.
Nov. 21, 1902.	Leonard, Edward, 2, Cannon Mount, Claughton, Cheshire.
Nov. 17, 1905.	Levett, Rev. Robert Kennedy, F.R.M.S., Ingram Gate, Thirsk, Yorkshire.
Jan. 17, 1908.	Levin, Arthur Everard, "Hillcroft," Shawfield Park, Bromley, Kent.
Nov. 25, 1887.	Lewer, J. J., 20, Crossfield Road, Belsize Park, N.W.
April 27, 1866.	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 41, The Park, Ealing, W.
June 26, 1868.	Lindley, W. H., jun., 29, Blittersdorffs Platz, Frankfort-on-Main.
Nov. 15, 1907.	Lindsay, Charles C., 8, Queen's Gate, Dowanhill, Glasgow.
April 19, 1907.	Littlejohn, Stanley William, 75, Arthur Road, N. Brixton, S.W.

Date of Election.

Feb. 16, 1906.	Lunn, John Horace, 11, Church Street, Tower Bridge Road, S.E.
Jan. 18, 1907.	Lyon, Massey, F.R.M.S., c/o Messrs. Coutts, 440, Strand, W.C.
May 21, 1897.	Mackenzie, James, 12, Cavendish Road, Brondesbury, N.W.
May 25, 1883.	Mainland, G. E., F.R.M.S., 14, The Norton, Tenby, South Wales.
June 17, 1898.	Marks, Kaufmann J., F.R.M.S., 4, Woodchurch Road, West Hampstead, N.W.
Feb. 15, 1895.	Marshall, William John, F.R.M.S., 56, Hazledene Road, Sutton Court, Chiswick, W.
Mar. 20, 1896.	Martin, Herbert Sydney, 10, Arngask Road, Catford, S.E.
April 15, 1904.	Martin, Victor Callingham, 8, Amherst Avenue, Ealing, W.
May 18, 1906.	Martin, William, "Kethlen," Burgh Heath, Epsom, Surrey.
Nov. 18, 1898.	Massee, G., F.L.S., Royal Gardens, Kew.
April 26, 1867.	Matthews, G. K., St. John's Lodge, Beckenham, Kent.
Jan. 15, 1892.	Maw, W. H., F.R.M.S., F.R.A.S., 18, Addison Road, Kensington, W.
Feb. 15, 1895.	Measures, John W., M.R.C.S., L.S.A.
Dec. 21, 1906.	Melady, John Hayes, 58, Ravenslea Road, Balham, S.W.
May 19, 1893.	Merlin, A. A. C. Eliot, F.R.M.S., British Consulate, Volo, Greece.
Oct. 18, 1907.	Mestayer, Richard L., M.I.C.E., F.R.M.S., Lambton Quay, Wellington, New Zealand.
July 27, 1877.	Michael, A. D., F.L.S., F.R.M.S. (*Vice-President*), The Warren, Studland, near Wareham, Dorset.
Mar. 20, 1896.	Micklewood, G. R.
May 17, 1901.	Miles, J. P., 34, Tyrrell Road, East Dulwich, S.E.
Nov. 16, 1906.	Miles, Lawrence, "Rosebank," Strawberry Hill, Twickenham.
July 7, 1865.	Millett, F. W., F.G.S., F.R.M.S., Eniscoe, Brixham, Devon.

Daty of Election.	
Jan. 20, 1905.	Milne, William, Uitenhage, Cape Colony, South Africa.
Oct. 18, 1907.	Minchin, Edward Alfred, M.A., F.Z.S. (President), 4, Tennyson Mansions, Cheyne Row, Chelsea, S.W.
Oct. 18, 1901.	Moore, Harry, F.R.M.S., 12, Whiston Grove, Moorgate, Rotherham, Yorks.
April 20, 1906.	Morgan, Sidney Frank, 14, Blackhorse Lane, Croydon.
July 26, 1878.	Morland, Henry, Cranford, near Hounslow.
Jan. 16, 1891.	Muiron, C., 49, Chatsworth Road, Brondesbury, N.W.
Feb. 15, 1907.	Mumford, Harry George, Kansanshi, N.W. Rhodesia.
Jan. 19, 1906.	Murray, Charles Walter.
June 16, 1905.	Myles, James Cellars, 53, Carlyle Road, Manor Park, S. Essex.
Mar. 24, 1876.	Nelson, E. M., F.R.M.S., Beckington, Bath.
May 16, 1902.	Nevill, Rev. T. J., F.R.M.S., 2, Grange Road, Eastbourne.
Nov. 25, 1881.	Nevins, R. T. G., Pembroke Lodge, Hildenborough, Tonbridge.
Feb. 15, 1907.	Newman, Charles Arnold, Oundle, Northants.
Jan. 26, 1872.	Newton, E. T., F.R.S., F.G.S., Florence House, Willow Bridge Road, Canonbury, N.
Jan. 17, 1908.	Nicholson, Alfred, 7, Belton Road, Sidcup.
June 15, 1894.	North, The Right Honble. Sir Ford, F.R.S., F.R.M.S. (*Vice-President*), 76, Queensborough Terrace, Bayswater, W.
June 4, 1909.	Oakenfull, Perrin, 25, The Gardens, Peckham Rye, S.E.
Feb. 16, 1900.	O'Donohoe, T. A., 8, Myrtle Road, Acton, W.
Jan. 24, 1879.	Offord, J. M., F.R.M.S., 3, Cleveland Gardens, West Ealing, W.
Dec. 22, 1876.	Ogilvy, C. P., F.L.S., Sizewell House, Leiston, near Saxmundham, Suffolk.
May 17, 1907.	Ogilvy, J. Wilson, F.R.M.S., 9, Oxford Street, W.

Date of Election.	
Nov. 15, 1907.	Oke, Alfred William, B.A., LL.M., 32, Denmark Villas, Hove.
Nov. 18, 1892.	Orfeur, Frank, F.R.M.S., 91, Effra Road, Brixton, S.W.
April 20, 1906.	Ormston, William John, 35, Penn Road, Holloway, N.
Dec. 27, 1867.	Oxley, Frederick, F.R.M.S., c/o A. E. Linton, Esq., Box 9, P.O., Nairobi, British East Africa.
Dec. 18, 1903.	Oxley, F. J., M.R.C.S., 1, Dock Street, E.
Feb. 19, 1904.	Page, John William, 13, Crescent Road, Sidcup, Kent.
Mar. 17, 1905.	Paine, Daniel George, 14, Cranstone Road, Forest Hill, S.E.
Oct. 27, 1871.	Parsons, F. A., 15, Osborne Road, Finsbury Park, N.
Dec. 16, 1904.	Patterson, George, The Flat, The Manbre Saccharine Co., Limited, Fulham Palace Road, Hammersmith, W.
Jan. 17, 1908.	Pattison, Charles Cuthbert, 5, Holmdale Road, West Hampstead, N.W.
July 23, 1886.	Paul, R., Holmbush, Cyprus Road, Exmouth, Devon.
Jan. 18, 1901.	Paulson, Robert, F.R.M.S., "Hosey," Cheney Lane, Pinner, Middlesex.
May 24, 1867.	Pearson, John, 40, Maida Vale, W.
Jan. 20, 1905.	Pearson, Mervyn Charles Hugh, Oatlands, Queen's Gardens, Ealing.
May 20, 1904.	Perks, Frederick John (*Hon. Treasurer*), 48, Grove Park, Denmark Hill, S.E.
Dec. 21, 1906.	Perrin, Charles Seale, 10, Lincoln Road, South Norwood, S.E.
Jan. 18, 1907.	Perry, Francis Gough, 2, The Cloisters, Gordon Square, W.C.
Mar. 17, 1905.	Phipps, William Joseph, 25, Grover Road, Bushey, Herts.
Feb. 20, 1903.	Pilcher, Charles Frederick, 68, Ham Park Road, Forest Gate, E.

Date of Election.	
Nov. 15, 1895.	Pillischer, J., F.R.M.S., 88, New Bond Street, W.
Dec. 21, 1906.	Pinch, Albert Edwin Hayward, 22, Chenies Street, W.C.
Mar. 18, 1904.	Pinkerton, William, 19, Langley Road, Watford.
June 19, 1903.	Piovanelli, Sebastiano C. E., 20, Via della Missione, Rome.
Nov. 19, 1897.	Pittock, George Mayris, M.B., F.R.M.S., Winton, Whitstable Road, Canterbury.
June 17, 1904.	Plaskitt, Frederic J. W., F.R.M.S., 12, Woodbridge Street, Clerkenwell, E.C.
Jan. 15, 1904.	Pledge, John H., F.R.M.S. (*Hon. Assistant Secretary*), 23, Canterbury Road, West Croydon, Surrey.
Nov. 23, 1883.	Plowman, T., Nystuen Lodge, Bycullah Park, Enfield.
Sept. 21, 1894.	Pollard, Jonathan, F.R.M.S., 10, Porteus Road, Paddington Green, W.
May 18, 1900.	Poser, M., F.R.M.S., 29, Margaret Street, Regent Street, W.
Dec. 20, 1907.	Potter, Arthur Sidney, "Voewood," Gayton Road, Harrow.
June 21, 1895.	Poulter, Christopher S., Mount Lodge, Parkhurst Road, Bexley, Kent.
Mar. 21, 1890.	Pound, C. J., F.R.M.S., Bacteriological Institute, Brisbane, Queensland.
Feb. 17, 1899.	Powell, Arthur, 28, Stafford Terrace, Kensington, W.
May 17, 1901.	Powell, David, M.A., F.R.M.S., 17, Warwick Mansions, Cromwell Crescent, Earl's Court, S.W.
July 7, 1865.	Powell, Thomas H., F.R.M.S., Emsdale, Greenham Road, Muswell Hill, N.
Feb. 16, 1894.	Praill, Edward, 3, Parkhill Road, Hampstead, N.W.
Dec. 20, 1907.	Pratt, John Edwin, 50, Chicester Road, Leytonstone, E.
Nov. 16, 1906.	Price, Edward Ebenezer, Oaklands, Oakland Road, Bromley Kent.

Date of Election.

June 4, 1909. Pring, S. W., Caversham, Newport, Isle of Wight.

Feb. 25, 1881. Probyn, Lieut.-Colonel Clifford, 55, Grosvenor Street, W.

Dec. 15, 1905. Pullin, Alfred James, 7, Amhurst Road, N.

Nov. 6, 1908. Quick, Albert Hedley, "Inverness," Malvern Road, Thornton Heath.

Jan. 18, 1901. Radley, Percy E., F.R.M.S., 30, Foxgrove Road, Beckenham, Kent.

Nov. 16, 1906. Reid, Dr. Duncan J., 20, Blakesley Avenue, Ealing.

Mar. 20, 1896. Rheinberg, Julius, F.R.M.S., 23, The Avenue, Brondesbury Park, N.W.

Sept. 18, 1891. Richards, F. W., 212, Notre Dame Street West, Montreal, Canada.

Oct. 2, 1908. Richards, Wllliam, 3, Favart Road, Fulham, S.W.

Jan. 18, 1901. Richardson, John, 30, Beaumont Avenue, Richmond, Surrey.

Nov. 6, 1908. Rink, Max, 4, Lydford Road, Willesden Green, N.W.

Jan. 19, 1894. Roberts, Charles Philip, 31, St. Mary's Road, Canonbury, N.

Nov. 16, 1906. Roberts, Edgar Hunt, 2, Priory Gardens, Highgate, N.

June 21, 1901. Robertson, H. R., F.R.M.S., Upton Grange, Chester.

Mar. 15, 1907. Robertson, James Alexander, F.R.M.S., 91, Bold Street, Fleetwood.

Jan. 18, 1907. Robertson, T. W., Burnton, Near Mount Vernon, Glasgow.

Jan. 19, 1906. Robins, Edmund Arthur, "Newlyn," Elm Park, Stanmore.

May 20, 1892. Robinson, J., 7, Longlands Road, Sidcup.

Nov. 16, 1900. Rogers, G. H. J., F.R.M.S., 55, King Street, Maidstone.

Jan. 25, 1884. Rosseter, T. B., F.R.M.S., East Kent Club, Canterbury.

Date of Election.

Jan. 26, 1883. Rousselet, Charles F. (*Vice-President and Hon. Secretary for Foreign Correspondence*), Curator R.M.S., 2, Pembridge Crescent, Bayswater, W.

Nov. 18, 1904. Rowley, Frederick Richard, F.R.M.S., 3, Devonshire Place, Pennsylvania Hill, Exeter.

Dec. 15, 1899. Royle, A. E., 56, St. Kilda's Road, Lordship Road, Stoke Newington, N.

Dec. 21, 1906. Ruscoe, Ernest Henry, 6, Great Castle Street, Regent Street, W.

April 27, 1888. Russell, J., 16, Blacket Place, Newington, Edinburgh.

Oct. 27, 1865. Russell, James, 38, Woodville Gardens, Ealing.

Nov. 21, 1902. Sanderson, R. Z., 26, Baronsfield Road, St. Margaret's, E. Twickenham, Middlesex.

April 2, 1909. Saxton, Thomas R., F.R.M.S., 43, East Bank, Stamford Hill, N.

Dec. 19, 1902. Sayers, H. M., Rusper Lodge, 11, Knollys Road, Streatham, S.W.

Nov. 15, 1907. Sayers, Lawrence Denton, 7, Cumberland Road, Kent, S.W.

Jan. 16, 1890. Scherren, H., F.Z.S., 9, Cavendish Road, Harringay, N.

Dec. 21, 1906. Scorer, Alfred George, Hillcrest, Chilworth, Guildford.

Feb. 18, 1898. Scott, David Bryce, Moncton, New Brunswick, Canada.

June 20, 1890. Scourfield, D. J., F.Z.S., F.R.M.S., 63, Queen's Road, Leytonstone, E.

May 20, 1898. Sears, Robert S. W., 1, Lisson Grove, N.W.

Feb. 15, 1901. Sexton, Louis E., L.D.S., 19, Portland Square, Plymouth.

Dec. 4, 1908. Sharpe, F. E., 28, Balham Park Road, S.W.

Nov. 6, 1908. Sharp, W. Marmaduke, "Merivale," Gayton Road, Harrow.

May 26, 1876. Shepheard, Thomas, F.R.M.S., Kingsley, Bournemouth West.

June 21, 1907. Sheppard, Alfred William, 1, Vernon Chambers, W.C.

Date of Election.

Feb. 21, 1908. Shorter, Ernest E., "Homecroft," Homecroft Road, Sydenham, S.E.

June 19, 1896. Sidwell, Clarence J. H., F.R.M.S. (*Hon. Curator*), 46, Ashbourne Grove, Dulwich, S.E.

Nov. 23, 1877. Simpson, T., "Fernymere," Castlebar, Ealing, W.

Feb. 17, 1905. Sindall, Robert Walter, 2, Oxford Court, Cannon Street, E.C.

Oct. 26, 1903. Skorikow, Alexander Stepanovic, Musée Zoologique de l'Académie Impériale des Sciences, St. Petersburg, Russia.

Oct. 23, 1868. Smart, William, 27, Aldgate, E.

May 25, 1866. Smith, Alpheus (*Hon. Librarian*), 14, Leigham Vale, Streatham, S.W.

Oct. 21, 1904. Smith, Arthur Edgar, "Helios," 71, Fox Lane, Palmer's Green, N.

Mar. 25, 1870. Smith, F. L., 3, Grecian Cottages, Crown Hill, Norwood, S.E.

Mar. 17, 1899. Smith, Frank P. (*Hon. Editor*), 5, Gibson Square, Islington, N.

Mar. 17, 1905. Smith, Frederick, 5, Devonshire Terrace, East Dulwich Road, S.E.

Nov. 19, 1897. Smith, Herbert Havet, "Levuka," Westcliff-on-Sea.

Nov. 18, 1898. Smith, Thomas J., F.R.M.S., c/o W. Watson & Sons, 313, High Holborn, W.C.

Jan. 17, 1902. Soames, Rev. Henry A., M.A., F.L.S., Lyncroft, Bromley, Kent.

Jan. 15, 1892. Soar, C. D., F.R.M.S., 37, Dryburgh Road, Putney, S.W.

May 17, 1901. Soutter, Andrew G., F.R.M.S., "Roseneath," 79, Bethune Road, Stamford Hill, N.

April 21, 1899. Spitta, Edmund J. (*Vice President*), L.R.C.P., M.R.C.S., F.R.A.S., F.R.M.S., 41, Ventnor Villas, Hove, Brighton.

April 21, 1899. Spitta, Dr. Harold, 12, Bolton Street, Mayfair, W.

Jan. 15, 1904. Sprague, T. B., LL.D., 29, Buckingham Terrace, Edinburgh.

Sept. 25, 1885. Spriggs, A. T., Bank of England, E.C.

Date of Election.

Jan. 18, 1907. Stahl, Arthur, 110, Ravensbourne Road, Shortlands, Kent.

Nov. 16, 1906. Stephens, Samuel Phillips, 15, Green Street, Kimberley, Cape Colony.

Nov. 17, 1899. Stevens, John, F.R.M.S., 50, St. David's Hill, Exeter.

Nov. 27, 1885. Stevenson, G. T., Ravenscroft, Haling Park Road, South Croydon.

June 18, 1897. Still, Arthur L., Sunnyside, Blakehall Road, Carshalton.

Nov. 16, 1894. Stokes, William B. (*Hon. Secretary*), 4, Winn Road, Burnt Ash Hill, Lee, S.E.

Dec. 15, 1893. Sturt, Gerald, "Lismore," Cavendish Road, Weybridge.

Jan. 18, 1901. Sully, F. Harold, 1, Twyford Crescent, Acton, W.

June 24, 1870. Swain, Ernest, Little Nalders, Chesham, Bucks.

May 17, 1895. Swan, Michael Edward, 45, Princes Square, Hyde Park, W.

Dec. 17, 1875. Swift, M. J., F.R.M.S., 6, Aylestone Avenue, Brondesbury.

Dec. 20, 1907. Swift, Mansell Powell, 6, Aylestone Avenue, Brondesbury.

April 17, 1891. Tabor, C. J., The White House, Knott's Green, Leyton, Essex.

Jan. 19, 1906. Taplin, Bruce, 16, Lordship Park, Stoke Newington, N.

Nov. 28, 1879. Tasker, J. G., 30, Junction Road, Upper Holloway, N.

Feb. 15, 1895. Tatham, John, M.A., M.D., Rathronan Lodge, The Avenue, Berrylands, Surbiton.

Oct. 16, 1896. Taverner, Henry, F.R.M.S., 319, Seven Sisters Road, Finsbury Park, N.

Feb. 17, 1905. Taylor, Thomas George, Bijou Villa, High Street, Ramsgate.

Dec. 22, 1865. Terry, John, 8, Hopton Road, Coventry Park, Streatham, S.W.

Mar. 16, 1894. Teversham, Fred. W., 317, Wightman Road, Hornsey, N.

Date of Election.	
Feb. 18, 1898.	Thelwell, F. W. Watts, "Tresillian," Harlyn Bay, near Padstow, Cornwall.
June 20, 1902.	Thomas, R. H., Warwickshire Estate, Salisbury, Rhodesia.
May 16, 1902.	Tilling, George, F.R.M.S., "Grasmere," Rydal Road, Streatham, S.W.
Dec. 21, 1894.	Traviss, Will. R., 42 Winchester Avenue, Brondesbury, N.W.
Mar. 5 1909.	Troughton, Henry George, 52, Lincoln's Inn Fields, W.C.
Nov. 21, 1902.	Tryon, B. F. T., Down Hall, Epsom, Surrey.
May 15, 1903.	Tupman, G. Lyon, Lt.-Col., F.R.M.S., College Road, Harrow.
June 17, 1892.	Turner, C., 20, Minster Road, Cricklewood, N.W.
June 21, 1901.	Tyrrell, E. G. Harcourt, c/o District Native Commissioner, 47, St. Andrews Street, Durban, Natal, S.A.
Mar. 16, 1900.	Underhill, T. H., M.B., 72, Herne Hill, S.E.
Mar. 16, 1906.	Vogeler, Gustav, 17, Philpot Lane, E.C.
July 25, 1873.	Walker, J. S., 6, Warwick Road, Upper Clapton, E.
Jan. 16, 1903.	Walker, Wallace O., Belle Vue House, Carey Place, Watford, Herts.
Nov. 20, 1903.	Waller, W. T., 15, Atney Road, Putney, S.W.
Oct. 19, 1900.	Webb, G. H. D., 111, Clifton Hill, St. John's Wood, N.W.
Feb. 17, 1905.	Webb, John Cooper, F.E.S., 218, Upland Road, Dulwich, S.E.
Dec. 21, 1900.	Webster, Rev. T., 13, Victoria Road, Exmouth, Devon.
June 16, 1899.	Wedeles, James, F.R.M.S., 231, Flinders Lane, Melbourne, Australia.
May 24, 1867.	Weeks, A. W. G., 36, Gunter Grove, West Brompton, S.W.
April 20, 1906.	Weeks, John, 8, Homefield Road, Bromley, Kent.
Feb. 15, 1901.	Wesché, Walter, F.R.M.S., 125, Biddulph Mansions, Elgin Avenue, W.

Date of Election.

Mar. 20, 1908. West, Joshua Cobbett, 20, Millbrook Road, Brixton, S.W.

Feb. 25, 1876. Wheeler, George, 64, Canonbury Park South, N.

June 25, 1880. Wickes, W. D., F.L.S., F.R.M.S., 20, Warrior Square, Southend-on-Sea.

Dec. 4, 1908. Wilkins, Thomas Smith, Eversley, Uttoxeter.

Nov. 23, 1877. Williams, G. S., Tor Hill, Kingskerswell, Devon.

Jan. 19, 1906. Wilson, Joseph, F.R.M.S., Hillside, Avon Road, Upper Walthamstow, Essex.

Mar. 20, 1908. Wingate, D. C., Cornborough, Abbotsham, Devon.

May 17, 1901. Winter, William F. G., 36, Grove Lane, Kingston-on-Thames.

Dec. 20, 1895. Wood, Walter J., F.R.M.S., "Ernecroft," Abbey Road, Grimsby.

Nov. 16, 1894. Wooderson, Edwin, "Königsfeld," 39, Dartmouth Road, Brondesbury, N.W.

Mar. 15, 1907. Worssam, Cecil, Hillside, St. Albans.

April 20, 1906. Worthington, Dr. Francis Samuel, The Beeches, Stowmarket.

Jan. 18, 1907. Wright, Joseph Pepper, 37, Ravenswood Road, Redland, Bristol.

Feb. 21, 1902. Wyatt, Edward, 27, Sudeley Street, Islington, N.

Jan. 18, 1901. Wykes, William, 7, Plaistow Park Road, Plaistow, Essex.

Nov. 23, 1888. Young, G. W., F.G.S., 34, Glenthorne Road, Hammersmith, W.

Nov. 15, 1907. Zehetmayr, Walter E., Belle Vue, St. Margaret's, Twickenham.

Dec. 19, 1902. Zimmerman, Prof. C., F.R.M.S., Collegio de S. Fiel, José Torre da Marca Porto, Portugal.

NOTICE.

Members are requested to give early information to the Treasurer of any change of residence, so as to prevent miscarriage of Journals and Circulars.

List of Exchanges and of Societies, etc., which Receive the Journal.

American Microscopical Society, c/o Prof. Henry P. Ward, University of Nebraska, Lincoln, Nebraska, U.S.A.

Bath Ladies' Microscopical Society, Miss B. Bryant, 15, Darlington Place, Bath.

Bausch & Lomb Optical Company, Publication Department, Rochester, N.Y., U.S.A.

Bergens Museums Bibliothek, Bergen, Norway.

Berlese, Prof. Antonio, R. Scuola di Agricoltura, Portici, Italy.

Birkbeck Literary and Scientific Institution, Bream's Buildings, Chancery Lane, W.C.

Birmingham Natural History and Philosophical Society, Norwich Union Chambers, Congreve Street, Birmingham.

"Botanical Gazette," University of Chicago Press, Chicago, Ill., U.S.A.

Botanical Society of Edinburgh (The Curator), The Botanic Gardens, Edinburgh.

Botanisches Centralblatt, c/o E. F. Brill, Leyden, Holland.

Brighton and Hove Natural History Society, c/o The Public Library, Brighton.

Bristol Naturalists' Society (The Librarian), 5, Lansdown Place, Clifton, Bristol.

British Association for the Advancement of Science, Burlington House, London, W.

Canadian Institute, W. H. Vandersmitten, Esq., Secretary 46, Richmond Street East, Toronto, Canada.

Concilium Bibliographicum, Zürich-Neumünster, Switzerland.

Croydon Natural History and Scientific Society (The Secretary), Public Hall, Croydon.

Deutsche mikrologische Gesellschaft, Pfizerstrasse, 5, Stuttgart, Germany.

Dohrn, Dr. Anton, The Zoological Station, Naples.

"English Mechanic," Clement's House, Clement's Inn Passage, W.C.

Entomological Society, 11, Chandos Street, Cavendish Square, W.

Essex Field Club, Essex Museum of Natural History, Stratford, Essex.

Geologists' Association (The Librarian), University College, Gower Street, W.C.

Herts Natural History Society, c/o Daniel Hill, Esq., "Herga," Watford, Herts.

Historical and Scientific Society of Manitoba, Winnipeg, Canada.

Horniman Museum, Forest Hill, S.E. (The Curator).

Hull Scientific and Field Naturalists' Club, Royal Institution, Hull.

Illinois State Laboratory of Natural History (Library), Urbana, Ill., U.S.A.

Imperial Leopold-Caroline Academy, Halle-on-the-Saale, Germany.

"Knowledge," c/o F. Shillington Scales, Esq., "Jersey," St. Barnabas Road, Cambridge.

Leicester Literary and Philosophical Society (The Secretary), Corporation Museum, Leicester.

Library, Bureau of Science, Manila, Philippines.

Linnean Society, Burlington House, Piccadilly, W.

Literary and Philosophical Society of Manchester (The Librarian), 36, George Street, Manchester.

Lloyd Library, Cincinnati, Ohio, U.S.A.

London Institution (The Librarian), Finsbury Circus, E.C.

Manchester Microscopical Society, J. E. Storey, Esq., 26, Grosvenor Road, Whalley Range, Manchester.

Microscopical Society of Liverpool, Royal Institution, Colquitt Street, Liverpool.

Missouri Botanical Garden, St. Louis, Mo., U.S.A.

Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne (The Librarian), Hancock Museum, Barras Bridge, Newcastle-upon-Tyne.

Natural History Museum (The Librarian), South Kensington, W.

Natural History Society of Glasgow (The Librarian), 207, Bath Street, Glasgow.

"Nature" (The Editor), St. Martin's Street, W.C.

Netherlands Zoological Society, Zoological Station, Helder, Holland.

New York Microscopical Society, c/o Rev. J. L. Zabuskie, Waverley Avenue, Flatbush, L.I., New York, U.S.A.

"Nuova Notarisia," c/o Prof. G. B. De Toni, Université Royale de Modena, Modena, Italy.

"Nyt Magazin for Naturaidenskaberne," c/o Prof. Dr. N. Wille. Botan. Garten, Christiania.

Oberhessische Gesellschaft für Natur- und Heilkunde, Giessen, Germany.

Optical Society (The Hon. Librarian), 20, Hanover Square, W.

Patent Office Library, 25, Southampton Buildings, Chancery Lane, W.C.

Philadelphia Academy of Natural Sciences, Philadelphia, Pa., U.S.A.

Philippine Exposition Board. Calle General Solano 384, Manila, Philippine Islands.

R. Scuola Superiore di Agricoltura, Portici, Italy.

Royal Dublin Society, Leinster House, Dublin.

Royal Institute of Cornwall, Truro.

Royal Institution, 21, Albemarle Street, W.

Royal Medical and Chirurgical Society, 20, Hanover Square, W.

Royal Microscopical Society, 20, Hanover Square, W.

Royal Society, Burlington House, Piccadilly, W.

Royal Society of New South Wales, Sydney.

Saunders, Sibert, Esq., 197, Amesbury Avenue, Streatham Hill, S.W.

Smithsonian Institution, Washington, D.C.

Société Belge de Microscopie, c/o Mons. A. Castaigne, 28, Rue de Berlaimont, Bruxelles.

Société Botanique Italienne, Florence, Italy.

Society of Arts, John Street, Adelphi, W.C.

Tempère, Mons. J., Grèz-sur-Loing, par Bourron, Seine et Marne.

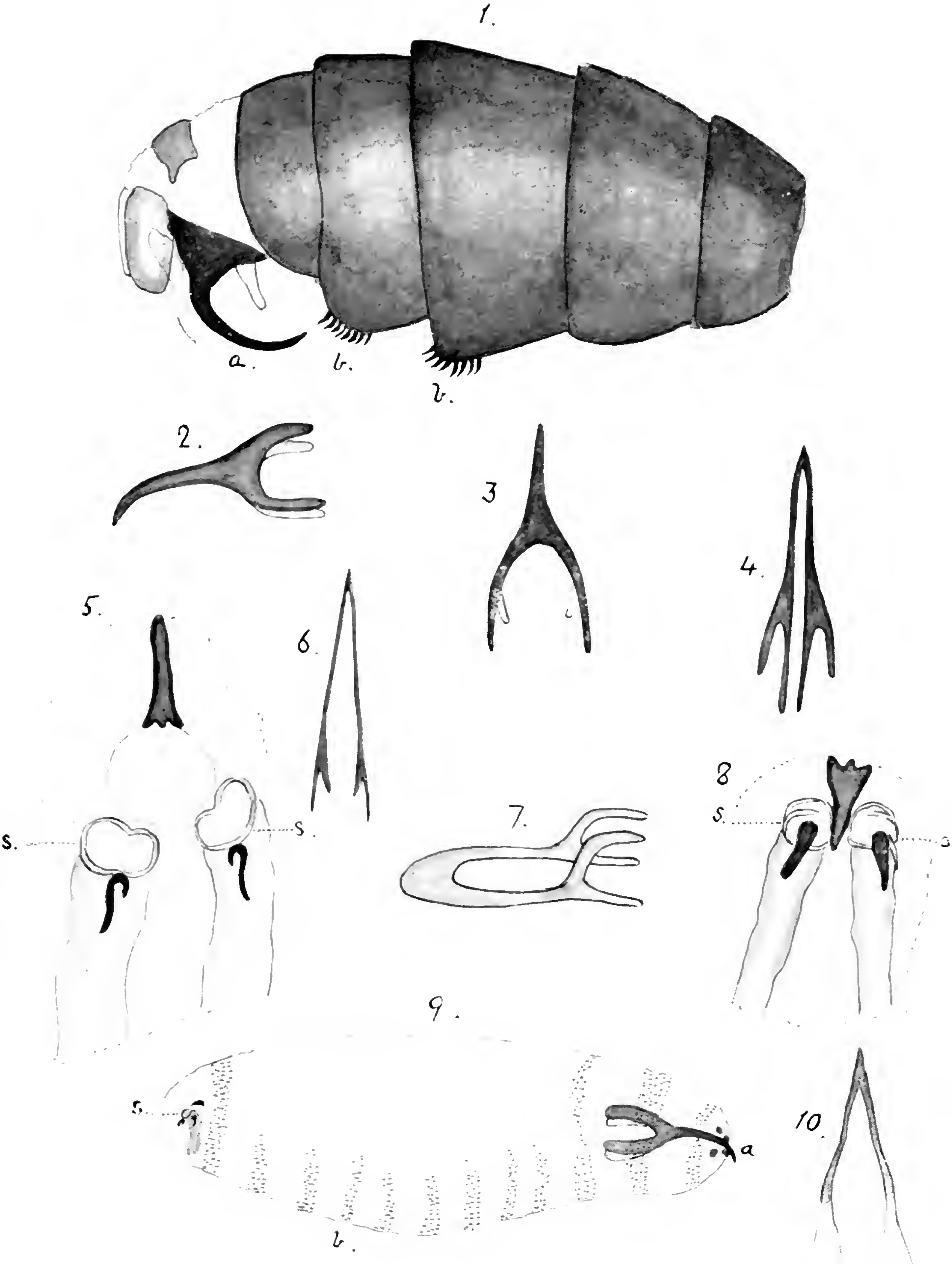
Wagner Free Institute, Montgomery Avenue and 17th Street, Philadelphia, U.S.A.

Wesenberg-Lund, Dr., Slotsgade, Hillerød, Denmark.

Wisconsin Academy of Sciences, Arts, and Letters (Exchange Secretary), Madison, Wis., U.S.A.

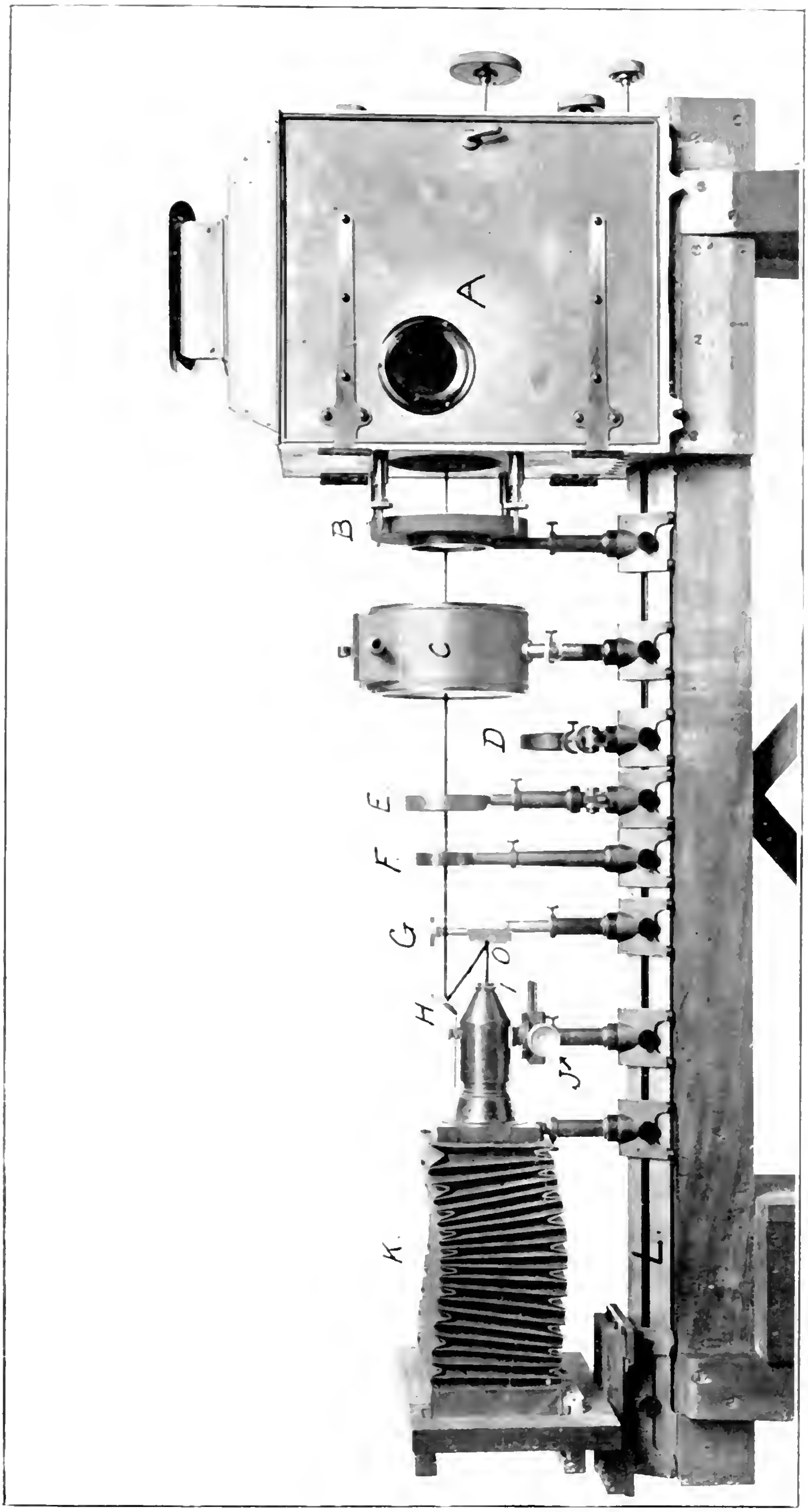
Zacharias, Dr. Otto, Biologische Station, Plön, Holstein, Germany.

Zoologisch-botanische Gesellschaft in Wien, III. 3, Mechelgasse Nr. 2, Wien, Austria.

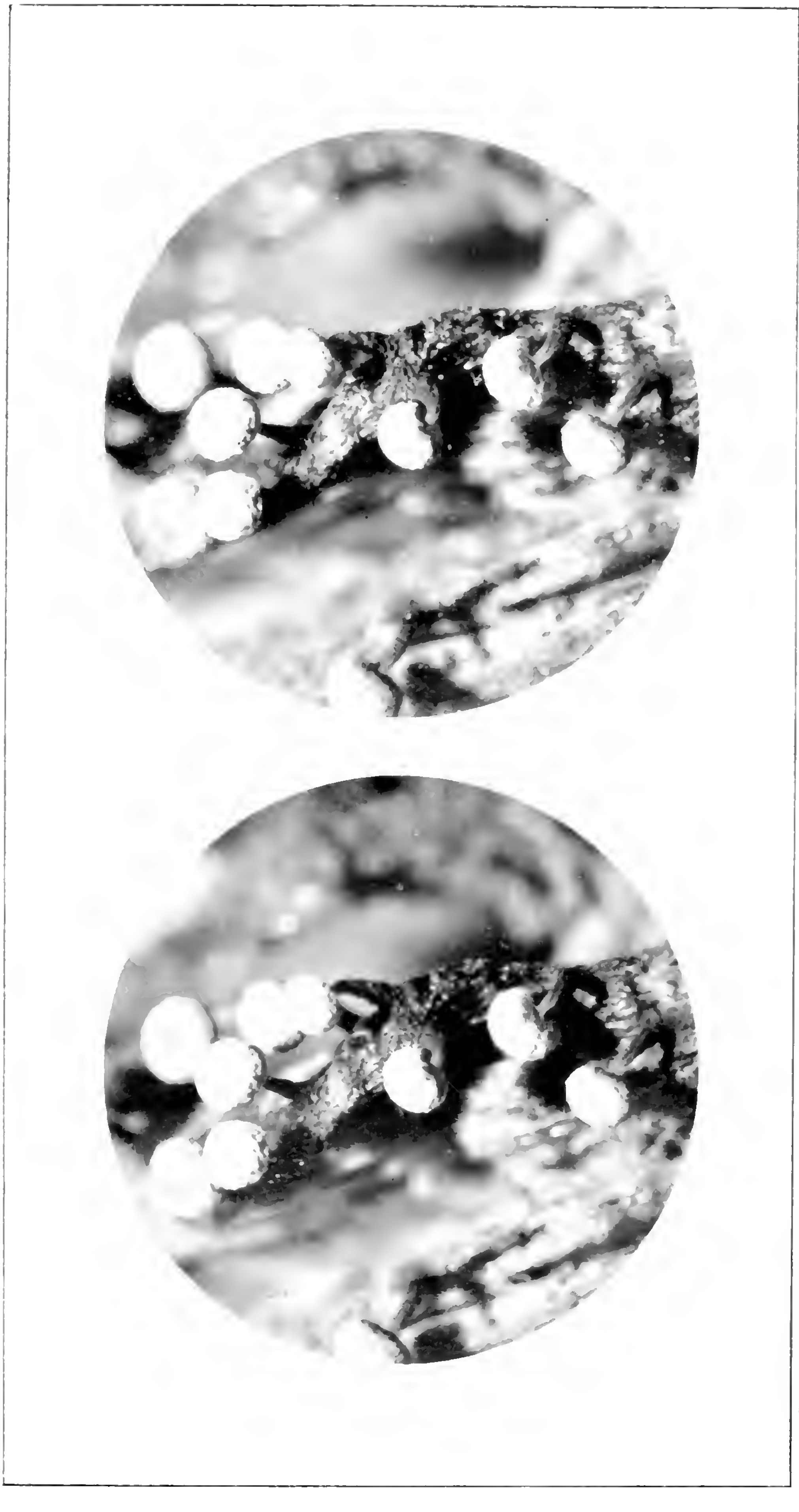


W. Wesche, *del. ad nat.*

Abdomen of Female and Larvae of *Phorocera serriventris*, etc

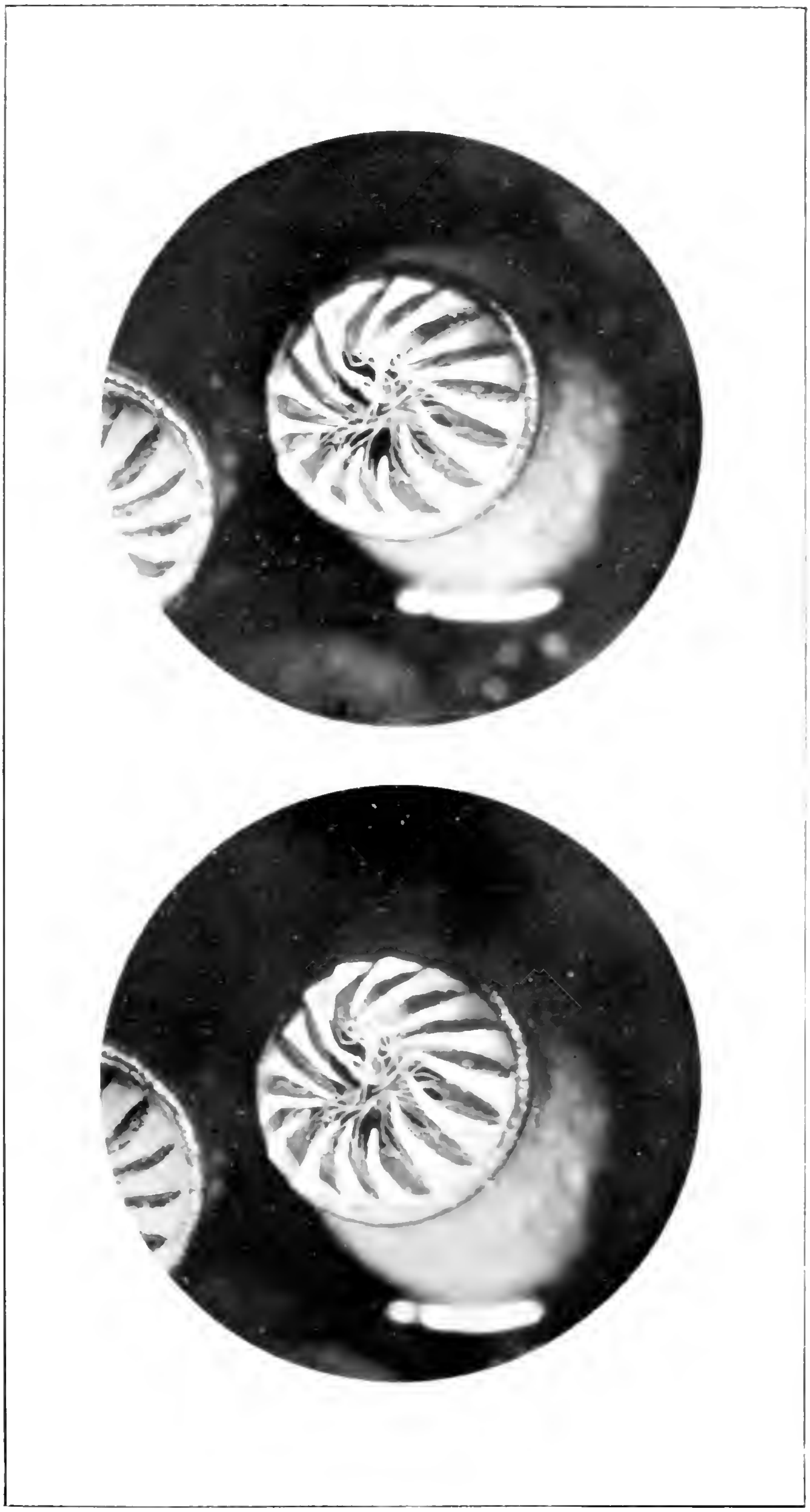


Apparatus for Stereo-Photomicrography.



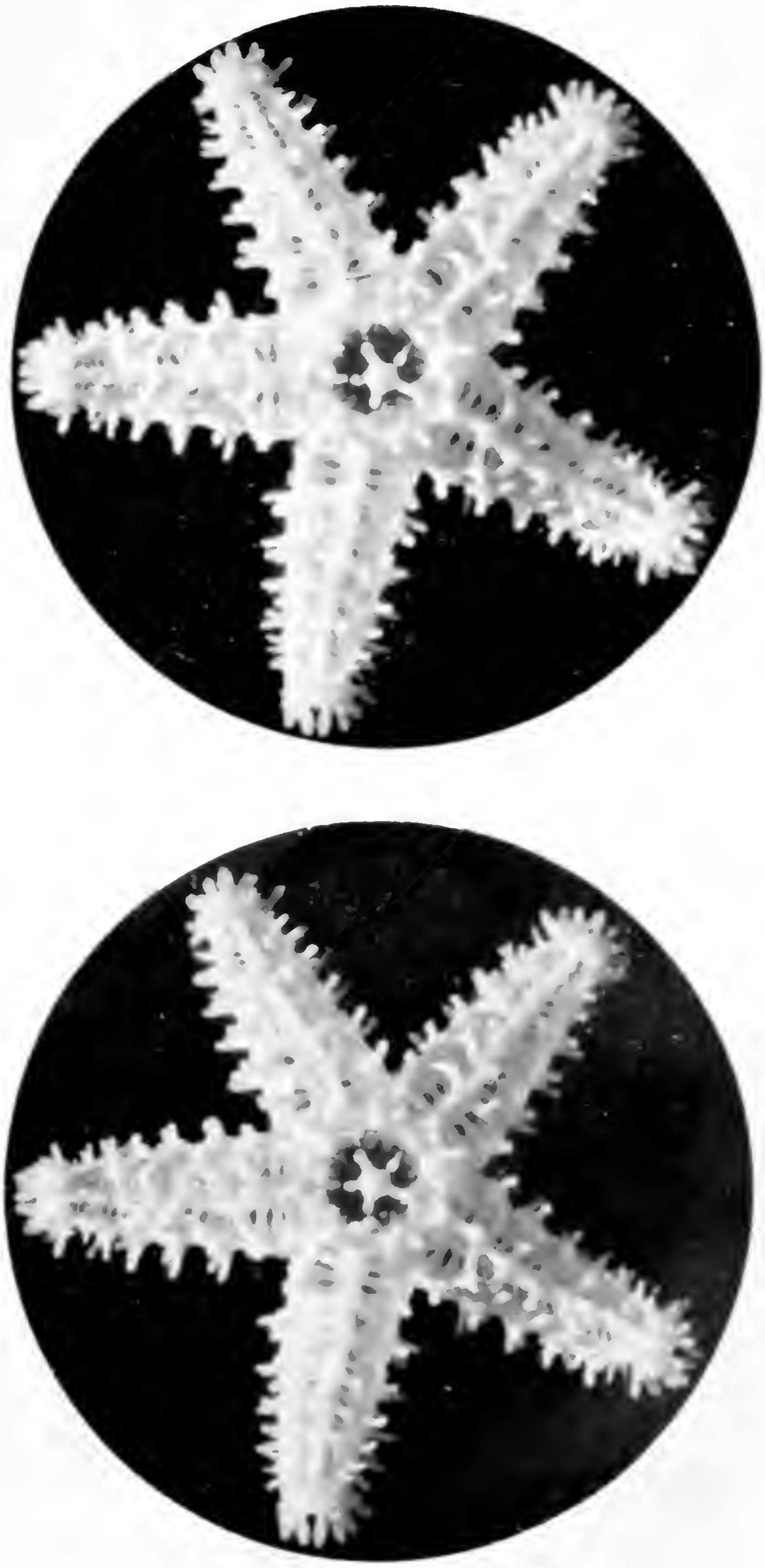
MYCETOZOA (*PHYSARUM NUTANS*).

A. C. BANFIELD, *Photo.*



A. C. Banfield, *Photo.*

Peristome of Moss (*Mnium undulatum*).



A. C. Banfield, *Photo.*

Skeleton of Young Starfish (*Asterias glacialis*).

Ser. 2, Vol. 10, No. 60.] APRIL, 1907. [Price 3s. 6d. net.

THE JOURNAL

OF THE

QUEKETT MICROSCOPICAL CLUB.

EDITED BY

FRANK P. SMITH.

(It will be understood that the Authors alone are responsible for the views and opinions expressed in their papers.)

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PAPERS.

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[PUBLISHED FOR THE CLUB]

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